# American Practical Navigator

## An Epitome of Navigation and Nautical Astronomy

By NATHANIEL BOWDITCH, LL. D., Etc.

HYDROGRAPHIC OFFICE

## ORDERS RELATING TO REVISION.

In accordance with the purpose contemplated in the purchase of the copyright of the NEW AMERICAN PRACTICAL NAVIGATOR, a thorough and complete revision has been made by Commander P. H. Cooper, U. S. Navy, acting under the direction of the Bureau. The revision consists principally in the substitution of the more concise and convenient methods of the present day for the obsolete methods of the past, and a complete rearrangement under proper chapters and paragraphs for ready reference, keeping in view, however, the character of the work as a Practical Navigator.

The revision having been completed, it was submitted to Capt. Ralph Chandler, U. S. Navy, for a final review, and having received a satisfactory report from that officer it has been accepted by the Bureau and will hereafter be substituted for the former editions of the work.

WILLIAM D. WHITING,
*Chief of Bureau.*

A revision of Bowditch's AMERICAN PRACTICAL NAVIGATOR having become necessary, the work has been completed by Lieut. G. W. Logan, U. S. Navy, under the supervision of the Hydrographer to the Bureau of Equipment. The revision was approved by a Board consisting of Capt. Colby M. Chester, U. S. Navy, Commander C. J. Badger, U. S. Navy, and Lieut. Commander C. C. Rogers, U. S. Navy. It is directed that this revised edition be substituted for all former editions.

R. B. BRADFORD,
*Chief of Bureau.*

2

# PREFACE.

The copyright of the NEW AMERICAN PRACTICAL NAVIGATOR, by the late Dr. Bowditch, became the property of the United States Government under the provision of an act of Congress to establish a Hydrographic Office in the Navy Department, approved June 21, 1866.

Under the direction of the Bureau of Navigation, at that time charged with such publications, the work was revised in 1880 by Commander P. H. Cooper, U. S. Navy, certain chapters being contributed by Lieuts. Richard Wainwright and Charles H. Judd, U. S. Navy, and the whole being reviewed by Capt. Ralph Chandler, U. S. Navy. The object of this revision was to improve the general arrangement, and to introduce the more convenient and precise methods of navigation that had come into practice since the book was originally written.

The progress that has been made in the science of navigation since 1880 has rendered necessary a second extensive revision, to take cognizance of the changes of methods and instruments that have accompanied the general introduction of high-speed vessels built of iron and steel. This work has been carried out, under the direction of the Bureau of Equipment, by Lieut. G. W. Logan, U. S. Navy, who was aided in the collection of data and preparation for publication by Lieut. T. A. Kearney, U. S. Navy; the chapters on Winds and Cyclonic Storms were contributed by Mr. James Page, nautical expert, Hydrographic Office.

There has been an extensive rewriting of the text, with the object of amplifying those matters that are of the greatest importance in the modern practice of navigation, and of omitting or condensing those of lesser importance; and the revision of the tables has proceeded along similar lines. This has involved, among other things, a much wider treatment of the subject of the compass; an extension of the traverse table for degrees to distances up to 600 miles; an improved table for reducing circum-meridian altitudes; the combination of the tables of maritime positions and tidal data; the omission of certain special methods for finding position by two observations; the addition of a series of annotated forms for the working of all sights, and the introduction of a number of new tables of use to the navigator.

The explanation of the method of lunar distances, with its accompanying tables, has been retained, in order to be available for use when required; but since this observation is so rarely employed in modern navigation, everything pertaining thereto has been incorporated in an appendix, that it may be distinct from matter of every-day use to the navigator.

For convenience in use the work has been divided into two parts, of which the first comprises the text and its appendices, and the second the tables.

W. H. H. SOUTHERLAND,
*Commander, U. S. Navy, Hydrographer.*

HYDROGRAPHIC OFFICE,
BUREAU OF EQUIPMENT, NAVY DEPARTMENT,
*Washington, D. C., March 19, 1903.*

3

# NOTE.

This edition is a reprint of the revised edition, 1903, with no change made in the text or tables of that edition except the correction of such errors as have been discovered in it to the present date.

JOHN J. KNAPP,
*Captain, U. S. Navy, Hydrographer.*

HYDROGRAPHIC OFFICE,
BUREAU OF NAVIGATION, NAVY DEPARTMENT,
*Washington, D. C., July 8, 1910.*

4

# PART I.

---

# TEXT AND APPENDICES.

# CONTENTS OF PART I.

# ABBREVIATIONS USED IN THIS WORK.

Alt. (or h) .......... Altitude.
A. M .............. Ante meridian.
Amp .............. Amplitude.
App ............... Apparent.
App. t ............. Apparent time.
Ast ............... Astronomical.
Ast. t ............. Astronomical time.
Aug .............. Augmentation.
Az. (or Z) .......... Azimuth.
C................. Course.
C. C ............. Chronometer correction.
C—W ............ Chronometer *minus* watch.
Chro. t............ Chronometer time.
Co. L............. Co. latitude.
Col .............. Column.
Corr.............. Correction.
Cos............... Cosine.
Cosec ............ Cosecant.
Cot .............. Cotangent.
d (or Dec.).......... Declination.
D (or DLo) ........ Difference longitude.
Dep .............. Departure.
Dev .............. Deviation.
Diff .............. Difference.
Dist .............. Distance.
DL ............... Difference latitude.
D. R.............. Dead reckoning.
E., Ely ............ East, easterly.
Elap. t............ Elapsed time.
Eq. eq. alt .......... Equation equal altitude.
Eq. t.............. Equation of time.
G. (or Gr.).......... Greenwich.
G. A. T............ Greenwich apparent time.
G. M. T........... Greenwich mean time.
G. S. T........... Greenwich sidereal time.
h................. Altitude.
H ................ Meridian altitude.
H. A. (or t)......... Hour angle.
H. D.............. Hourly difference.
H. P. (or Hor. par.)... Horizontal parallax.
Hr-s.............. Hour-s.
H. W ............. High water.
I. C .............. Index correction.
L. (or Lat.) ........ Latitude.
L. A. T............ Local apparent time.

L. M. T ............ Local mean time.
L. S. T ............ Local sidereal time.
Lo. (or Long)....... Longitude.
Log............... Logarithm.
Lun. Int............ Lunitidal interval.
L. W ............. Low water.
m ................ Meridional difference.
Merid ............ Meridian or noon.
Mag ............. Magnetic.
M. D ............. Minute's difference.
Mid .............. Middle.
Mid. L............ Middle latitude.
M. T.............. Mean time.
N., Nly ........... North, northerly.
N. A. (or Naut. Alm.). Nautical Almanac.
Np ............... Neap.
Obs............... Observation.
p (or P. D.).......... Polar distance.
p. c .............. Per compass.
P. D. (or p)......... Polar distance.
P. L. (or Prop. Log.). Proportional logarithm.
P. M.............. Post meridian.
p. & r............. Parallax and refraction.
Par .............. Parallax.
R. A.............. Right ascension.
R. A. M. S......... Right ascension mean sun.
Red .............. Reduction.
Ref .............. Refraction.
S., Sly ............ South, southerly.
S. D .............. Semi-diameter.
Sec .............. Secant.
Sid .............. Sidereal.
Sin .............. Sine.
Spg.............. Spring.
t ................ Hour angle.
T................ Time.
Tab.............. Table.
Tan .............. Tangent.
Tr. (or Trans.) ...... Transit.
Var.............. Variation.
Vert.............. Vertex or vertical.
W., Wly .......... West, westerly.
W. T ............. Watch time.
z................ Zenith distance.
Z................ Azimuth.

## SYMBOLS.

| | | | |
|---|---|---|---|
| ☉ | The Sun. | ° | Degrees. |
| ☾ | The Moon. | ′ | Minutes of Arc. |
| ✳ | A Star or Planet. | ″ | Seconds of Arc. |
| ☉☾ | Alt. upper limb. | h | Hours. |
| ☉☾ | Alt. lower limb. | m | Minutes of Time. |
| φ☉ | Azimuthal angle. | s | Seconds of Time. |

## GREEK LETTERS.

A α ..Alpha.
B β ..Beta.
Γ γ ..Gamma.
Δ δ ..Delta.
E ε ..Epsilon.
Z ζ ..Zeta.
H η ..Eta.
Θ θ ..Theta.
I ι ...Iota.
K κ ..Kappa.
Λ λ ..Lambda.
M μ ..Mu.

N ν .....Nu.
Ξ ξ .....Xi.
O o .....Omicron.
Π π.....Pi.
P ρ. ....Rho.
Σ σ (ς)..Sigma.
T τ .....Tau.
Υ υ .....Upsilon.
Φ φ.....Phi.
X χ .....Chi.
Ψ ψ.....Psi.
Ω ω ....Omega.

# CHAPTER I.

## DEFINITIONS RELATING TO NAVIGATION.

**1.** That science, generally termed *Navigation*, which affords the knowledge necessary to conduct a ship from point to point upon the earth, enabling the mariner to determine, with a sufficient degree of accuracy, the position of his vessel at any time, is properly divided into two branches: *Navigation* and *Nautical Astronomy*.

**2.** *Navigation*, in its limited sense, is that branch which treats of the determination of the position of the ship by reference to the earth, or to objects thereon. It comprises (*a*) *Piloting*, in which the position is ascertained from visible objects upon the earth, or from soundings of the depth of the sea, and (*b*) *Dead Reckoning*, in which the position at any moment is deduced from the direction and amount of a vessel's progress from a known point of departure.

**3.** *Nautical Astronomy* is that branch of the science which treats of the determination of the vessel's place by the aid of celestial objects—the sun, moon, planets, or stars.

**4.** Navigation and Nautical Astronomy have been respectively termed *Geo-Navigation* and *Celo-Navigation*, to indicate the processes upon which they depend.

**5.** As the method of piloting can not be employed excepting near land or in moderate depths of water, the navigator at sea must fix his position either *by dead reckoning* or *by observation* (*of celestial objects*); the latter method is more exact, but as it is not always available, the former must often be depended upon.

**6.** THE EARTH.—The Earth is an oblate spheroid, being a nearly spherical body slightly flattened at the poles; its longer or equatorial axis measures about 7,927 statute miles, and its shorter axis, around which it rotates, about 7,900 statute miles.

The Earth (assumed for purposes of illustration to be a sphere) is represented in figure 1.

The *Axis of Rotation*, usually spoken of simply as the *Axis*, is PP'.

The *Poles* are the points, P and P', in which the axis intersects the surface, and are designated, respectively, as the *North Pole* and the *South Pole*.

The *Equator* is the great circle EQMW, formed by the intersection with the earth's surface of a plane perpendicular to the axis; the equator is equidistant from the poles, every point upon it being 90° from each pole.

*Meridians* are the great circles PQP', PMP', PM'P', formed by the intersection with the earth's surface of planes secondary to the equator (that is, passing through its poles and therefore perpendicular to its plane).

*Parallels of Latitude* are small circles NT*n*, N'*n*'T', formed by the intersection with the earth's surface of planes passed parallel to the equator.

The *Latitude* of a place on the surface of the earth is the arc of the meridian intercepted between the equator and that place. Latitude is reckoned *North* and *South*, from the equator as an origin, through 90° to the poles; thus, the



FIG. 1.

latitude of the point T is MT, north, and of the point T', M'T', north. The *Difference of Latitude* between any two places is the arc of a meridian intercepted between their parallels of latitude, and is called *North* or *South*, according to direction; thus, the difference of latitude between T and T' is T*n*' or T'*n*, north from T or south from T'.

The *Longitude* of a place on the surface of the earth is the arc of the equator intercepted between its meridian and that of some place from which the longitude is reckoned. Longitude is measured *East* or *West* through 180° from the meridian of a designated place, such meridian being termed the *Prime Meridian;* the prime meridian used by most nations, including the United States, is that of Greenwich, England. If, in the figure, the prime meridian be PGQP', then the longitude of the point T is QM, east, and of T', QM', east. The *Difference of Longitude* between any two places is the arc of the equator intercepted between their meridians, and is called *East* or *West*, according to direction; thus, the difference of longitude between T and T' is MM', east from M or west from M'. The *Departure* is the linear distance, measured on a parallel of latitude, between two meridians; unlike the various quantities previously defined, departure is reckoned in miles; the departure between two meridians varies with the parallel of latitude upon which it is measured; thus, the departure between the meridians of T and T' is the number of miles corresponding to the distance T*n* in the latitude of T, or to *n*'T' in the latitude of T'.
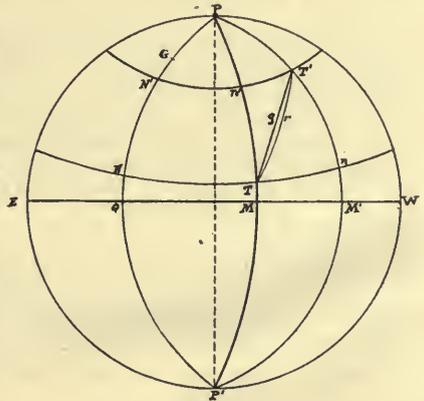
The curved line which joins any two places on the earth's surface, cutting all the meridians at the same angle, is called the *Rhumb Line*, *Loxodromic Curve*, or *Equiangular Spiral*. In the figure, this line is represented by $TrT'$. The constant angle which this line makes with the meridians is called the *Course;* and the length of the line between any two places is called the *Distance* between those places.

The unit of linear measure employed by navigators is the *Nautical* or *Sea Mile*, or *Knot*. It is equal to one minute of latitude—that is, to the length of that portion of a meridian which subtends at the earth's center the angular measure of one minute; since, however, on account of the fact that the earth is not a perfect sphere, this distance is not exactly the same in all latitudes, a mean value is adopted for the length of the knot, and it is regarded as equal to 6,080.27 feet. For the purposes of navigation, the variation from this value in different latitudes is so small that it may be neglected, and the knot may be assumed equal to a minute of latitude in all parts of the earth; hence, when a vessel changes her position to the north or south by one nautical mile, it may always be considered that the latitude has changed 1'. Owing to the fact that the meridians all converge toward the poles, the difference of longitude produced by a change of position of one mile to the east or west will vary with the latitude; thus a departure of one mile will equal a difference of longitude of 1'.0 at the equator, of 1'.1 in the latitude of 30°, and of 2'.0 in the latitude of 60°.

The *Great Circle Track* or *Course* between any two places is the route between those places along the circumference of the great circle which joins them. In the figure, this line is represented by $TgT'$. From the properties of a great circle (which is a circle upon the earth's surface formed by the intersection of a plane passed through its center) the distance between two points measured on a great circle track is shorter than the distance upon any other line which joins them. Except when the two points are on the same meridian or when both lie upon the equator, the great circle track will always differ from the rhumb line, and the great circle track will intersect each intervening meridian at a different angle.

# CHAPTER II.

## INSTRUMENTS AND ACCESSORIES IN NAVIGATION.

### DIVIDERS OR COMPASSES.

**7.** This instrument consists of two legs movable about a joint, so that the points at the extremities of the legs may be set at any required distance from each other. It is used to take and transfer distances and to describe arcs and circles. When used for the former purpose it is termed *dividers*, and the extremities of both legs are metal points; when used for describing arcs or circles, it is called a *compass*, and one of the metal points is replaced by a pencil or pen.

### PARALLEL RULERS.

**8.** *Parallel rulers* are used for drawing lines parallel to each other in any direction, and are particularly useful in transferring the rhumb-line on the chart to the nearest compass-rose to ascertain the course, or to lay off bearings and courses.

### PROTRACTOR.

**9.** This is an instrument used for the measurement of angles upon paper; there is a wide variation in the material, size, and shape in which it may be made. (For a description of the *Three Armed Protractor*, see art. 432, Chap. XVII.)

### THE CHIP LOG.

**10.** This instrument, for measuring the rate of sailing, consists of three parts; viz, the *log-chip*, the *log-line*, and the *log-glass*. A light substance thrown from the ship ceases to partake of the motion of the vessel as soon as it strikes the water, and will be left behind on the surface; after a certain interval, if the distance of the ship from this stationary object be measured, the approximate rate of sailing will be given. The *log-chip* is the float, the *log-line* is the measure of the distance, and the *log-glass* defines the interval of time.

The *log-chip* is a thin wooden quadrant of about 5 inches radius, loaded with lead on the circular edge sufficiently to make it swim upright in the water. There is a hole in each corner of the log-chip, and the log-line is knotted in the one at the apex; at about 8 inches from the end there is seized a wooden socket; a piece of line of proper length, being knotted in the other holes, has seized into its bight a wooden peg to fit snugly into the socket before the log-chip is thrown; as soon as the line is checked this peg pulls out, thus allowing the log-chip to be hauled in with the least resistance.

The *log-line* is about 150 fathoms in length, one end made fast to the log-chip, the other to a reel upon which it is wound. At a distance of from 15 to 20 fathoms from the log-chip a permanent mark of red bunting about 6 inches long is placed to allow sufficient *stray line* for the log-chip to clear the vessel's eddy or wake. The rest of the line is divided into lengths of 47 feet 3 inches called *knots*, by pieces of fish-line thrust through the strands, with one, two, three, etc., knots, according to the number from stray-line mark; each knot is further subdivided into five equal lengths of two-tenths of a knot each, marked by pieces of white rag.

The length of a knot depends upon the number of seconds which the log-glass measures; the length of each knot must bear the same ratio to the nautical mile ($\frac{1}{60}$ of a degree of a great circle of the earth or 6,080 feet) that the time of the glass does to an hour.

In the United States Navy all log-lines are marked for log glasses of 28 seconds, for which the proportion is:

$$3600 : 6080 = 28^s : x,$$

$x$ being the length of the knot.

Hence,

$$x = 47^{ft}.29, \text{ or } 47^{ft} \, 3^{in}.$$

The speed of the ship is estimated in knots and tenths of a knot.

The *log-glass* is a sand glass of the same shape and construction as the old hour-glass. Two glasses are used, one of 28 seconds and one of 14 seconds; the latter is employed when the ship is going at a high rate of speed, the number of knots indicated on a line marked for a 28-second glass being doubled to obtain the true rate of speed.

**11.** The log in all its parts should be frequently examined and adjusted; the peg must be found to fit sufficiently tight to keep the log-chip upright; the log-line shrinks and stretches and should often be verified; the log-glass should be compared with a watch. One end of the glass is stopped with a cork, by removing which the sand may be dried or its quantity corrected.

**12.** A *ground log* consists of an ordinary log-line, with a lead attached instead of a chip; in shoal water, where there are no well-defined objects available for fixing the position of the vessel and the course and speed are influenced by a tidal or other current, this log is sometimes used, its advantage being that the lead marks a stationary point to which motion may be referred, whereas the chip would drift with the stream. The speed, which is marked in the usual manner, is the speed over the ground, and the trend of the line gives the course actually made good by the vessel.

## THE PATENT LOG.

**13.** This is a mechanical contrivance for registering the distance actually run by a vessel through the water. There are various types of patent logs, but for the most part they act upon the same principle, consisting of a registering device, a fly or rotator, and a log or tow line; the rotator is a small spindle with a number of wings extending radially in such manner as to form a spiral, and, when drawn through the water in the direction of its axis, rotates about that axis after the manner of a screw propeller; the rotator is towed from the vessel by means of a log or tow line from 20 to 50 fathoms in length, made fast at its apex, the line being of special make so that the turns of the rotator are transmitted through it to the worm shaft of the register, to which the inboard end of the line is attached; the registering device is so constructed as to show upon a dial face the distance run, according to the number of turns of its worm shaft due to the motion of the rotator; the register is carried at some convenient point on the vessel's quarter; it is frequently found expedient to rig it out upon a small boom, so that the rotator will be towed clear of the wake.

**14.** Though not a perfect instrument, the patent log affords the most accurate means available for determining the vessel's speed through the water. It will usually be found that the indications of the log are in error by a constant percentage, and the amount of this error should be determined by careful experiment and applied to all readings.

Various causes may operate to produce inaccuracy of working in the patent log, such as the bending of the wings of the rotator by accidental blows, fouling of the rotator by sea weed or refuse from the ship, or mechanical wear of parts of the register. The length of the tow-line has much to do with the working of the log, and by varying the length the indications of the instrument may sometimes be adjusted when the percentage of error is small; it is particularly important that the line shall not be too short. The readings of the patent log can not be depended upon for accuracy at low speeds, when the rotator does not tow horizontally, nor in a head or a following sea, when the effect depends upon the wave motion as well as upon the speed of the vessel.

**15.** Electrical registers for patent logs are in use, the distance recorded by the mechanical register being communicated electrically to some point of the vessel which is most convenient for the purposes of those charged with the navigation.

**16.** A number of instruments based upon different physical principles have been devised for recording the speed of a vessel through the water and have been used with varying degrees of success.

**17.** The revolutions of the screw propeller afford in a steamer a valuable check upon the patent log and a means of replacing it if necessary. To be of service the number of revolutions per knot must be carefully determined for the vessel by experiment under varying conditions of speed, draft, and foulness of bottom.

## THE LEAD.

**18.** This device, for ascertaining the depth of water, consists essentially of a suitably marked line, having a lead attached to one of its ends. It is an invaluable aid to the navigator in shallow water, particularly in thick or foggy weather, and is often of service when the vessel is out of sight of land.

Two leads are used for soundings—the *hand-lead*, weighing from 7 to 14 pounds, with a line marked to about 25 fathoms, and the *deep-sea lead*, weighing from 30 to 100 pounds, the line being 100 fathoms or upward in length.

Lines are generally marked as follows:

| | |
|---|---|
| 2 fathoms from the lead, with 2 strips of leather. | 17 fathoms from the lead, same as at 7 fathoms. |
| 3 fathoms from the lead, with 3 strips of leather. | 20 fathoms from the lead, with 2 knots. |
| 5 fathoms from the lead, with a white rag. | 25 fathoms from the lead, with 1 knot. |
| 7 fathoms from the lead, with a red rag. | 30 fathoms from the lead, with 3 knots. |
| 10 fathoms from the lead, with leather having a hole in it. | 35 fathoms from the lead, with 1 knot. |
| 13 fathoms from the lead, same as at 3 fathoms. | 40 fathoms from the lead, with 4 knots. |
| 15 fathoms from the lead, same as at 5 fathoms. | And so on. |

Fathoms which correspond with the depths marked are called *marks;* the intermediate fathoms are called *deeps;* the only fractions of a fathom used are a half and a quarter.

A practice sometimes followed is to mark the hand-lead line in feet around the critical depths of the vessel by which it is to be used.

Lead lines should be measured frequently while wet and the correctness of the marking verified. The distance from the leadsman's hand to the water's edge should be ascertained in order that proper allowance may be made therefor in taking soundings at night.

**19.** The deep-sea lead may be *armed* by filling with tallow a hole hollowed out in its lower end, by which means a sample of the bottom is brought up.

## THE SOUNDING MACHINE.

**20.** This machine possesses advantages over the deep-sea lead, for which it is a substitute, in that soundings may be obtained at great depths and with rapidity and accuracy without stopping the ship. It consists essentially of a stand holding a reel upon which is wound the sounding wire, and which is controlled by a suitable brake. Crank handles are provided for reeling in the wire after the sounding has been taken. Attached to the outer end of the wire is the lead, which has a cavity at its lower end for the reception of the tallow for arming. Above the lead is a cylindrical case containing the depth-registering mechanism; various devices are in use for this purpose, all depending, however, upon the increasing pressure of the water with increasing depths.

**21.** In the *Lord Kelvin machine* a slender glass tube is used, sealed at one end and open at the other, and coated inside with a chemical substance which changes color upon contact with sea water; this tube is placed, closed end up, in the metal cylinder; as it sinks the water rises in the tube, the contained air being compressed with a force dependent upon the depth. The limit of discoloration is marked by a clearly defined line, and the depth of the sounding corresponding to this line is read off from a scale. Tubes that have been used in comparatively shallow water may be used again where the water is known to be deeper.

**22.** A tube whose inner surface is *ground* has been substituted for the chemical-coated tube, ground glass, when wet, showing clear. The advantage of these tubes is that they may be used an indefinite number of times if thoroughly dried. To facilitate drying, a rubber cap is fitted to the upper end, which, when removed, admits of a circulation of the air through the tube.

**23.** As a substitute for the glass tubes a mechanical *depth recorder* contained in a suitable case has been used. In this device the pressure of the water acts upon a piston against the tension of a spring. A scale with an index pointer records the depth reached. The index pointer must be set at zero before each sounding.

**24.** Since the action of the sounding machine, when glass tubes are used, depends upon the compression of the air, the barometric pressure of the atmosphere must be taken into account when accurate results are required. The correction consists in *increasing* the indicated depth by a fractional amount according to the following table:

| Bar. reading. | Increase. |
|---|---|
| " | |
| 29. 75 | One-fortieth. |
| 30. 00 | One-thirtieth. |
| 30. 50 | One-twentieth. |
| 30. 75 | One-fifteenth. |

### THE MARINER'S COMPASS.

**25.** The *Mariner's Compass* is an instrument consisting either of a single magnet, or, more usually, of a series of magnets, which, being attached to a graduated circle pivoted at the center and allowed to
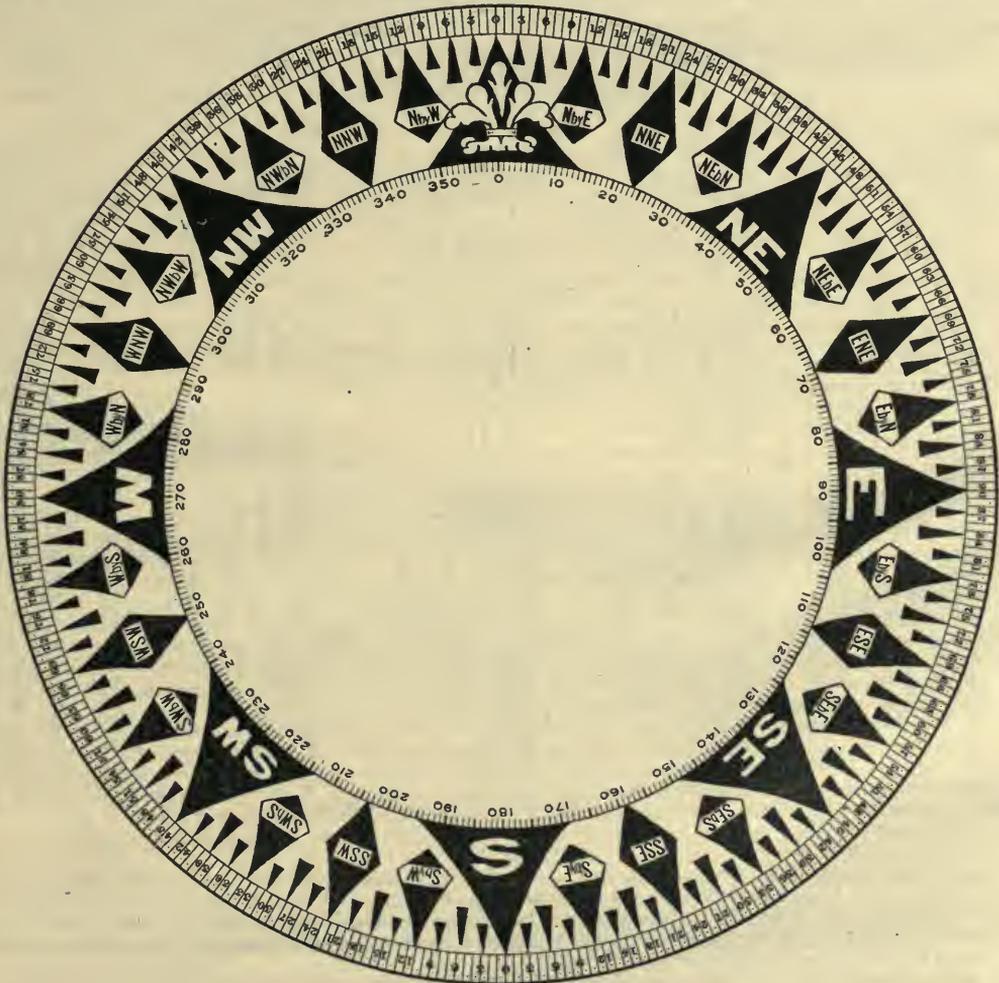


Fig. 2.

swing freely in a horizontal plane, has a tendency to lie with its magnetic axis in the plane of the earth's magnetic meridian, thus affording a means of determining the azimuth, or horizontal angular distance from that meridian, of the ship's course and of all visible objects, terrestrial or celestial.

**26.** The circular card of the compass (fig. 2) is divided on its periphery into 360°, numbered from 0° at North and South to 90° at East and West; also into thirty-two divisions of 11¼° each, called *points*, the latter being further divided into *half-points* and *quarter-points;* still finer subdivisions, *eighth-points*, are sometimes used, though not indicated on the card. A system of numbering the degrees from 0° to 360°, always increasing toward the right, is shown in the figure. This system is in use by the mariners of some nations, and its general adoption would carry with it certain undoubted advantages.

**27.** *Boxing the Compass* is the process of naming the points in their order, and is one of the first things to be learned by the young mariner. The four principal points are called *cardinal points* and are named North, South, East, and West; each differs in direction from the adjacent one by 90°, or 8 points. Midway between the cardinal points, at an angular distance of 45°, or 4 points, are the *inter-cardinal* points, named according to their position Northeast, Southeast, etc. Midway between each cardinal and inter-cardinal point, at an angular distance of 22½°, or 2 points, is a point whose name is made up of a combination of that of the cardinal with that of the inter-cardinal point: North-Northeast, East-Northeast, East-Southeast, etc. At an angular distance of 1 point, or 11¼°, from each cardinal and inter-cardinal point (and therefore midway between it and the 22½°-division last described), is a point which bears the name of that cardinal or inter-cardinal point joined by the word *by* to that of the cardinal point in the direction of which it lies: North by East, Northeast by North, Northeast by East, etc.

In boxing by fractional points, it is evident that each division may be referred to either of the whole points to which it is adjacent; for instance, NE. by N. ½ N. and NNE. ½ E. would describe the same division. It is the custom in the United States Navy to box *from* North and South *toward* East and West, excepting that divisions adjacent to a cardinal or inter-cardinal point are always referred to that point; as N. ½ E., N. by E. ½ E., NNE. ½ E., NE. ½ N., etc. Some mariners, however, make it a practice to box *from* each cardinal and inter-cardinal point *toward* a 22½°-point (NNE., ENE., etc.); as N. ½ E., N. by E. ½ E., NE. by N. ½ N., NE. ½ N., etc.

The names of the whole points, together with fractional points (according to the nomenclature of the United States Navy), are given in the following table, which shows also the degrees, minutes, and seconds from North or South to which each division corresponds:

| N. to E. | N. to W. | S. to E. | S. to W. | Pts. | Angular measure. | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | | ° | ′ | ″ |
| North: | North: | South: | South: | | | | |
| N. ¼ E | N. ¼ W | S. ¼ E | S. ¼ W | ¼ | 2 | 48 | 45 |
| N. ½ E | N. ½ W | S. ½ E | S. ½ W | ½ | 5 | 37 | 30 |
| N. ¾ E | N. ¾ W | S. ¾ E | S. ¾ W | ¾ | 8 | 26 | 15 |
| N. by E | N. by W | S. by E | S. by W | 1 | 11 | 15 | 00 |
| N. by E. ¼ E | N. by W. ¼ W | S. by E. ¼ E | S. by W. ¼ W | 1¼ | 14 | 03 | 45 |
| N. by E. ½ E | N. by W. ½ W | S. by E. ½ E | S. by W. ½ W | 1½ | 16 | 52 | 30 |
| N. by E. ¾ E | N. by W. ¾ W | S. by E. ¾ E | S. by W. ¾ W | 1¾ | 19 | 41 | 15 |
| NNE | NNW | SSE | SSW | 2 | 22 | 30 | 00 |
| NNE. ¼ E | NNW. ¼ W | SSE. ¼ E | SSW. ¼ W | 2¼ | 25 | 18 | 45 |
| NNE. ½ E | NNW. ½ W | SSE. ½ E | SSW. ½ W | 2½ | 28 | 07 | 30 |
| NNE. ¾ E | NNW. ¾ W | SSE. ¾ E | SSW. ¾ W | 2¾ | 30 | 56 | 15 |
| NE. by N | NW. by N | SE. by S | SW. by S | 3 | 33 | 45 | 00 |
| NE. ¾ N | NW. ¾ N | SE. ¾ S | SW. ¾ S | 3¼ | 36 | 33 | 45 |
| NE. ½ N | NW. ½ N | SE. ½ S | SW. ½ S | 3½ | 39 | 22 | 30 |
| NE. ¼ N | NW. ¼ N | SE. ¼ S | SW. ¼ S | 3¾ | 42 | 11 | 15 |
| NE | NW | SE | SW | 4 | 45 | 00 | 00 |
| NE. ¼ E | NW. ¼ W | SE. ¼ E | SW. ¼ W | 4¼ | 47 | 48 | 45 |
| NE. ½ E | NW. ½ W | SE. ½ E | SW. ½ W | 4½ | 50 | 37 | 30 |
| NE. ¾ E | NW. ¾ W | SE. ¾ E | SW. ¾ W | 4¾ | 53 | 26 | 15 |
| NE. by E | NW. by W | SE. by E | SW. by W | 5 | 56 | 15 | 00 |
| NE. by E. ¼ E | NW. by W. ¼ W | SE. by E. ¼ E | SW. by W. ¼ W | 5¼ | 59 | 03 | 45 |
| NE. by E. ½ E | NW. by W. ½ W | SE. by E. ½ E | SW. by W. ½ W | 5½ | 61 | 52 | 30 |
| NE. by E. ¾ E | NW. by W. ¾ W | SE. by E. ¾ E | SW. by W. ¾ W | 5¾ | 64 | 41 | 15 |
| ENE | WNW | ESE | WSW | 6 | 67 | 30 | 00 |
| ENE. ¼ E | WNW. ¼ W | ESE. ¼ E | WSW. ¼ W | 6¼ | 70 | 18 | 45 |
| ENE. ½ E | WNW. ½ W | ESE. ½ E | WSW. ½ W | 6½ | 73 | 07 | 30 |
| ENE. ¾ E | WNW. ¾ W | ESE. ¾ E | WSW. ¾ W | 6¾ | 75 | 56 | 15 |
| E. by N | W. by N | E. by S | W. by S | 7 | 78 | 45 | 00 |
| E. ¾ N | W. ¾ N | E. ¾ S | W. ¾ S | 7¼ | 81 | 33 | 45 |
| E. ½ N | W. ½ N | E. ½ S | W. ½ S | 7½ | 84 | 22 | 30 |
| E. ¼ N | W. ¼ N | E. ¼ S | W. ¼ S | 7¾ | 87 | 11 | 15 |
| East | West | East | West | 8 | 90 | 00 | 00 |

**28.** The compass card is mounted in a bowl which is carried in *gimbals*, thus enabling the card to retain a horizontal position while the ship is pitching and rolling. A vertical black line called the *lubber's line* is marked on the inner surface of the bowl, and the compass is so mounted that a line joining its pivot with the lubber's line is parallel to the keel line of the vessel; thus the lubber's line always indicates the compass direction of the ship's head.

**29.** According to the purpose which it is designed to fulfill, a compass is designated as a *Standard*, *Steering*, *Check*, or *Boat Compass*.

**30.** There are two types of compass in use, the *wet* or *liquid* and the *dry;* in the former the bowl is filled with liquid, the card being thus partially buoyed, with consequent increased ease of working on the pivot, and the liquid further serving to decrease the vibrations of the card when deflected by reason of the motion of the vessel or other cause. On account of its advantages the liquid compass is used in the United States Navy.

**31.** The Navy Service 7½-inch Liquid Compass.—This consists of a skeleton card 7½ inches in diameter, made of tinned brass, resting on a pivot in liquid, with provisions for two pairs of magnets symmetrically placed.

The magnet system of the card consists of four cylindrical bundles of steel wires; these wires are laid side by side and magnetized as a bundle between the poles of a powerful electromagnet. They are afterwards placed in a cylindrical case, sealed, and secured to the card. Steel wires made up into a bundle were adopted because they are more homogeneous, can be more perfectly tempered, and for the same weight give greater magnetic power than a solid steel bar.

Two of the magnets are placed parallel to the north and south diameter of the card, and on the chords of 15° (nearly) of a circle passing through their extremities. These magnets penetrate the air vessel, to which they are soldered, and are further secured to the bottom of the ring of the card. The other two magnets of the system are placed parallel to the longer magnets on the chords of 45° (nearly) of a circle passing through their extremities, and are secured to the bottom of the ring of the card.

The card is of a curved annular type, the outer ring being convex on the upper and inner side, and is graduated to read to one-fourth point, a card circle being adjusted to its outer edge and divided to half-degrees, with legible figures at each 3°, for use in reading bearings by an azimuth circle or in laying the course to degrees.

The card is provided with a concentric spheroidal air vessel, to buoy its own weight and that of the magnets, allowing a pressure of between 60 and 90 grains on the pivot at 60° F.; the weight of the card in air is 3,060 grains. The air vessel has within it a hollow cone, open at its lower end, and provided with the pivot bearing, or cap, containing a sapphire, which rests upon the pivot and thus supports the card; the cap is provided with adjusting screws for accurately centering the card. The pivot is fastened to the center of the bottom of the bowl by a flanged plate and screws. Through this plate and the bottom of the bowl are two small holes which communicate with the expansion chamber and admit of a circulation of the liquid between it and the bowl. The pivot is of gun metal with an iridium cap.

The card is mounted in a bowl of cast bronze, the glass cover of which is closely packed with rubber, preventing the evaporation or leakage of the liquid, which entirely fills the bowl. This liquid is composed of 45 per cent pure alcohol and 55 per cent distilled water, and remains liquid below −10° F.

The lubber's line is a fine line drawn on an enameled plate on the inside of the bowl, the inner surface of the latter being covered with an insoluble white paint.

Beneath the bowl is a metallic self-adjusting expansion chamber of elastic metal, by means of which the bowl is kept constantly full without the show of bubbles or the development of undue pressure caused by the change in volume of the liquid due to changes of temperature.

The rim of the compass bowl is made rigid and its outer edge turned strictly to gauge to receive the azimuth circle.

**32.** The Dry Compass.—The *Lord Kelvin Compass*, which may be regarded as the standard for the nonliquid type, consists of a strong paper card with the central parts cut away and its outer edge stiffened by a thin aluminum ring. The pivot is fitted with an iridium point, upon which rests a small light aluminum boss fitted with a sapphire bearing. Radiating from this boss are 32 silk threads whose outer ends are made fast to the inner edge of the compass card; these threads sustain the weight of the suspended card, and, as they possess some elasticity, tend to decrease the shocks due to motion.

Eight small steel wire needles, 3¼ to 2 inches long, are secured normally to two parallel silk threads, and are slung from the aluminum rim of the card by other silk threads which pass through eyes in the ends of the outer pair of needles. The needles are below the radial threads, thus keeping the center of gravity low.

**33.** The Azimuth Circle.—This is a necessary fitting for all compasses employed for taking bearings—that is, noting the directions—of either celestial or terrestrial objects. The instrument varies widely in its different forms; the essential features which all share consist in (a) a pair of sight vanes, or equivalent device, at the extremities of the diameter of a circle that revolves concentrically with the compass bowl, the line of sight thus always passing through the vertical axis of the compass; and (b) a system, usually of mirrors and prisms, by which the point of the compass card cut by the vertical plane through the line of sight—in other words, the compass direction—is brought into the field of view of the person making the observation. In some circles, for observing azimuths of the sun advantage is taken of the brightness of that body to reflect a pencil of light upon the card in such a manner as to indicate the compass direction; such an azimuth circle is used in the United States Navy.

**34.** Binnacles.—Compasses are mounted for use in stands known as *Binnacles*, of which there are two principal types—the *Compensating* and the *Non-Compensating Binnacle*, so designated according as they are or are not equipped with appliances by which the deviation of the compass, or error in its indications due to disturbing magnetic features within the ship, may be compensated.

Binnacles may be of wood or of some nonmagnetic metal; all contain a compass chamber within which the compass is suspended in its gimbal ring, the knife edges upon which it is suspended resting in V-shaped bearings; an appropriate method is supplied for centering the compass. A hood is provided for the protection of the compass and for lighting it at night. Binnacles must be rigidly secured to the deck of the vessel in such position that the lubber's line of the compass gives true indications of the direction of the ship's head.

The position of the various binnacles on shipboard and the height at which they carry the compass must be chosen with regard to the purpose which the compass is to serve, having in mind the magnetic conditions of the ship.

Compensating binnacles contain the appliances for carrying the various correctors used in the compensation of the deviation of the compass. These consist of (a) a system of permanent magnets for

semicircular deviation, placed in a magnet chamber lying immediately beneath the compass chamber, so arranged as to permit variation in the height and direction of the magnets employed; (*b*) a pair of arms projecting horizontally from the compass chamber and supporting masses of soft iron for quadrantal deviation; (*c*) a central tube in the vertical axis of the binnacle for a permanent magnet used to correct the heeling error, and (*d*) an attachment, sometimes fitted, for securing a vertical soft iron rod, or "Flinders bar," used in certain cases for correction of a part of the semicircular deviation. An explanation of the various terms here used, together with the method of compensating the compass, will be given in Chapter III.

## THE PELORUS.

**35.** This instrument consists of a circular plate, mounted horizontally in gimbals upon a vertical standard, at some point on board ship affording a clear view for taking bearings; radial scores upon a raised flange on the periphery of this plate indicate true directions from its center parallel with the keel line of the vessel and perpendicular thereto—in other words, lines of bearing directly ahead, astern, and abeam. Revolving about a common center, which is also the center of the plate, are (*a*) a dumb compass card, usually engraved on metal, whose face is level with the raised periphery of the plate on which are marked the scores, and (*b*) a pivoted horizontal bar carrying at its extremities a pair of sight vanes so arranged that the line of sight always passes through the vertical axis of the instrument, and having an index showing the point at which the line of sight cuts the dumb compass. The dumb compass and the sight-vane bar can each be rigidly clamped.

The instrument is used for taking bearings, and may be more convenient than the compass for that purpose because of the better view that it affords, as well as because it may be made to eliminate the compass error from observed bearings. Suppose that the dumb compass be revolved until the degree or division which is coincident with the right-ahead score of the plate is the same as that which is abreast the lubber's line of the ship's compass. Then all directions indicated by the dumb compass will be parallel to the corresponding directions of the live one, and all bearings taken by the pelorus will be identical with those taken by the compass (leaving out of the question the diffence due to the distance that separates them). Suppose, now, that it is known that the ship's compass has a certain error and that the correct direction that we seek (which is the one indicated on the charts) is a certain angular distance to the right or left of that which the compass shows; if, in such a case, instead of setting the pelorus for the direction indicated by compass, we set it for the correct direction in which we know the ship to be heading, all bearings observed by the pelorus will be correct bearings as given by the chart and may be plotted directly thereon without the necessity for the intermediate process of correction to which the bearings shown by compass are subject. It will at once be evident that the indications of the pelorus will be accurate only when bearings are taken at an instant when the ship is heading exactly in the direction for which it is set, and care must be taken accordingly in its use.

The most modern types of pelorus are fitted for illuminating the dumb compass, thus greatly facilitating night work.

## THE CHART.

**36.** A nautical *chart* is a miniature representation upon a plane surface, in accordance with a definite system of projection or development, of a portion of the navigable waters of the world. It generally includes the outline of the adjacent land, together with the surface forms and artificial features that are useful as aids to navigation, and sets forth the depths of water, especially in the near approaches to the land, by soundings that are fixed in position by accurate determinations. Except in charts of harbors or other localities so limited that the curvature of the earth is inappreciable on the scale of construction, a nautical chart is always framed over with a network of parallels of latitude and meridians of longitude in relation to which the features to be depicted on the chart are located and drawn; and the mathematical relation between the meridians and parallels of the chart and those of the terrestrial sphere determines the method of measurement that is to be employed on the chart and the special uses to which it is adapted.

**37.** There are three principal systems of projection in use: (*a*) the *Mercator*, (*b*) the *polyconic*, and (*c*) the *gnomonic;* of these, the Mercator is by far the most generally used for purposes of navigation proper, while the polyconic and the gnomonic charts are employed for nautical purposes in a more restricted manner, as for plotting surveys or for facilitating great circle sailing.

**38.** THE MERCATOR PROJECTION.—The *Mercator Projection*, so called, may be said to result from the development, upon a plane surface, of a cylinder which is tangent to the earth at the equator, the various points of the earth's surface having been projected upon the cylinder in such manner that the *loxodromic curve* or *rhumb line* (art. 6, Chap. I) appears as a right line preserving the same angle of bearing with respect to the intersected meridians as does the ship's track.

In order to realize this condition, the line of tangency, which coincides with the earth's equator, being the circumference of a right section of the cylinder, will appear as a right line on the development; while the series of elements of the cylinder corresponding to the projected terrestrial meridians will appear as equidistant right lines, parallel to each other and perpendicular to the equator of the chart, maintaining the same relative positions and the same distance apart on that equator as the meridians have on the terrestrial spheroid. The series of terrestrial parallels will also appear as a system of right lines parallel to each other and to the equator, and will so intersect the meridians as to form a system of rectangles whose altitudes, for successive intervals of latitude, must be variable, increasing from the equator in such manner that the angles made by the rhumb line with the meridian on the chart may maintain the required equality with the corresponding angles on the spheroid.

**39.** MERIDIONAL PARTS.—At the equator a degree of longitude is equal to a degree of latitude, but in receding from the equator and approaching the pole, while the degrees of latitude remain always of the same length (save for a slight change due to the fact that the earth is not a perfect sphere), the degrees of longitude become less and less.

Since, in the Mercator projection, the degrees of longitude are made to appear everywhere of the same length, it becomes necessary, in order to preserve the proportion that exists at different parts of the earth's surface between degrees of latitude and degrees of longitude, that the former be increased from their natural lengths, and such increase must become greater and greater the higher the latitude.

The length of the meridian, as thus increased, between the equator and any given latitude, expressed in minutes at the equator as a unit, constitutes the number of *Meridional Parts* corresponding to that latitude. The Table of Meridional Parts or Increased Latitudes (Table 3), computed for every minute of latitude between 0° and 80°, affords facilities for constructing charts on the Mercator projection and for solving problems in Mercator sailing.

**40.** To Construct a Mercator Chart.—If the chart for which a projection is to be made includes the equator, the values to be measured off are given directly by Table 3. If the equator does not come upon the chart, then the parallels of latitude to be laid down should be referred to a *principal parallel*, preferably the lowest parallel to be drawn on the chart. The distance of any other parallel of latitude from the principal parallel is then the difference of the values for the two taken from Table 3.

The values so found may either be measured off, without previous numerical conversion, by means of a diagonal scale constructed on the chart, or they may be laid down on the chart by means of any properly divided scale of yards, meters, feet, or miles, after having been reduced to the scale of proportions adopted for the chart.

If, for example, it be required to construct a chart on a scale of one-quarter of an inch to five minutes of arc on the equator, a diagonal scale may first be constructed, on which ten meridional parts, or ten minutes of arc on the equator, have a length of half an inch.

It may often be desirable to adapt the scale to a certain allotment of paper. In this case, the lowest and the highest parallels of latitude may first be drawn on the sheet on which the transfer is to be made. The distance between these parallels may then be measured, and the number of meridional parts between them ascertained. Dividing the distance by this number will then give the length of one meridional part, or the quantity by which *all* the meridional parts taken from Table 3 must be multiplied. This quantity will represent the *scale of the chart*. If it occurs that the limits of longitude are a governing consideration, the case may be similarly treated.

Example: Let a projection be required for a chart of 14° extent in longitude between the parallels of latitude 20° 30′ and 30° 25′, and let the space allowable on the paper between these parallels measure 10 inches.

Entering the column in Table 3 headed 20°, and running down to the line marked 30′ in the side column, will be found 1248.9; then, entering the column 30°, and running down to the line of 25′, will be found 1905.5. The difference, or $1905.5 - 1248.9 = 656.6$, is the value of the meridional arc between these latitudes, for which 1′ of arc of the equator is taken as the unit. On the intended projection, therefore, 1′ of arc of longitude will measure $\frac{10^{in.}}{656.6} = 0.0152$ inch, which will be the scale of the chart.

For the sake of brevity call it 0.015. By this quantity all the values derived from Table 3 will have to be multiplied before laying them down on the projection, if they are to be measured on a diagonal scale of one inch.

Draw in the center of the sheet a straight line, and assume it to be the middle meridian of the chart. Construct very carefully on this line a perpendicular near the lower border of the sheet, and assume this perpendicular to be the parallel of latitude 20° 30′; this will be the southern inner neat line of the chart. From the intersection of the lines lay off on the parallel, on each side of the middle meridian, seven degrees of longitude, or distances each equal to $0.015 \times 60 \times 7 = 6.3$ inches; and through the points thus obtained draw parallel lines to the middle meridian, and these will be the eastern and western neat lines of the chart.

In order to construct the parallel of latitude for 21° 00′, find, in Table 3, the meridional parts for 21° 00′, which are 1280.8. Subtracting from this number the number for 20° 30′, and multiplying the difference by 0.015, we obtain 0.478 inch, which is the distance on the chart between 20° 30′ and 21° 00′. On the meridians lay off distances equal to 0.478 inch, and through the three points thus obtained draw a straight line, which will be the parallel of 21° 00′.

Proceed in the same manner to lay down all the parallels answering to full degrees of latitude; the distances will be respectively:

$$0^{in}.015 \times (1344.9 - 1248.9) = 1.440 \text{ inches,}$$
$$0^{in}.015 \times (1409.5 - 1248.9) = 2.409 \text{ inches,}$$
$$0^{in}.015 \times (1474.5 - 1248.9) = 3.384 \text{ inches, etc.}$$

Thus will be shown the parallels of latitude 22° 00′, 23° 00′, 24° 00′, etc. Finally, lay down in the same way the parallel of latitude 30° 25′, which will be the northern inner neat line of the chart.

A degree of longitude will measure on this chart $0^{in}.015 \times 60 = 0^{in}.9$. Lay off, therefore, on the lowest parallel of latitude drawn on the chart, on a middle one, and on the highest parallel, measuring from the middle meridian toward each side, the distances of $0^{in}.9$, $1^{in}.8$, $2^{in}.7$, $3^{in}.6$, etc., in order to determine the points where meridians answering to full degrees cross the parallels drawn on the chart. Through the points thus found draw the meridians. Draw then the outer neat lines of the chart at a convenient distance outside of the inner neat lines, and extend to them the meridians and parallels. Between the inner and outer neat lines of the chart subdivide the degrees of latitude and longitude as minutely as the scale of the chart will permit, the subdivisions of the degrees of longitude being found by dividing the degrees into equal parts, and the subdivisions of the degrees of latitude being accurately found in the same manner as the full degrees of latitude previously described, though it will generally be found sufficiently exact to make even subdivisions of the degrees, as in the case of the longitude.

The subdivisions between the two eastern as well as those between the two western neat lines will serve for measuring or estimating terrestrial distances. Distances between points bearing North and South of each other may be ascertained by referring them to the subdivisions between the same parallels. Distances represented by lines at an angle to the meridians (loxodromic lines) may be measured

by taking between the dividers a small number of the subdivisions near the middle latitude of the line to be measured, and stepping them off on that line.   If, for instance, the terrestrial length of a line running at an angle to the meridians between the parallels of latitude of 24° 00′ and 29° 00′ be required, the distance shown on the neat space between 26° 15′ and 26° 45′ (=30 nautical miles) may be taken between the dividers and stepped off on that line.

**41.** Coast lines and other positions are plotted on the chart by their latitude and longitude.   A chart may be transferred from any other projection to that of Mercator by drawing a system of corresponding parallels of latitude and meridians over both charts so close to each other as to form minute squares, and then the lines and characters contained in each square of the map to be transferred may be copied by the eye in the corresponding squares of the Mercator projection.

Since the unit of measure, the mile or minute of latitude, has a different value in every latitude, there is an appearance of distortion in a Mercator chart that covers any large extent of surface; for instance, an island near the pole will be represented as being much larger than one of the same size near the equator, due to the different scale used to preserve the character of the projection.

**42.** THE POLYCONIC PROJECTION.—This projection is based upon the development of the earth's surface on a series of cones, a different one for each parallel of latitude, each one having the parallel as its base, and its vertex in the point where a tangent to the earth at that latitude intersects the earth's axis. The degrees of latitude and longitude on this chart are projected in their true length, and the general distortion of the figure is less than in any other method of projection, the relative magnitudes being closely preserved.

A straight line on the polyconic chart represents a great circle, making a slightly different angle with each successive meridian as the meridians converge toward the pole and are theoretically curved lines; but it is only on charts of large extent that this curvature is apparent; the parallels are also curved, this fact being apparent to the eye upon all excepting the largest scale charts.

This method of projection is especially adapted to the plotting of surveys; it is also employed for nearly all of the charts of the United States Coast and Geodetic Survey.

**43.** GNOMONIC PROJECTION.—This is based upon a system in which the plane of projection is tangent to the earth at some given point; the eye of the spectator is situated at the center of the sphere, where, being at once in the plane of every great circle, it will see all such circles projected as straight lines where the visual rays passing through them intersect the plane of projection.   In a gnomonic chart, a straight line between any two points is projected as an arc of a great circle, and is therefore the shortest line between those points.

Excepting in the Polar regions, for which latitudes the Mercator projection can not be constructed, the gnomonic charts are not used for general navigating purposes.   Their greatest application is to afford a ready means of finding the course and distance at any time in great circle sailing, the method of doing which will be explained in Chapter V.

**44.** MERIDIANS EMPLOYED IN CHART CONSTRUCTION.—The United States, England, Germany, Italy, Russia, Norway, Sweden, Denmark, Holland, Austria, Portugal, and Japan adopt as a prime meridian the *meridian of Greenwich.*

France adopts the *meridian of Paris* in Long. 2° 20′ 14″.5 E. of Greenwich.

Spain adopts the *meridian of San Fernando, Cadiz,* in Long. 6° 12′ 20″ W. of Greenwich.

The Pulkowa Observatory of St. Petersburg (sometimes referred to in Russian charts) is in Long. 30° 19′ 39″.6 E. of Greenwich.

The Royal Observatory of Naples (sometimes referred to in Italian charts) is in Long. 14° 14′ 06″ E. of Greenwich.

The meridian of Genoa is 8° 55′ 21″ E.; of Lisbon, 9° 08′ 36″ W.; of Rio de Janeiro, 43° 10′ 21″.2 W.; of Amsterdam, 4° 53′ 03″.8 E.; of Washington, 77° 03′ 56″.7 W.

**45.** QUALITY OF BOTTOM.—The following table shows the qualities of the bottom, as expressed on charts of various nations:

| United States. | English. | French. | Italian. | Spanish. | German. |
|---|---|---|---|---|---|
| Clay............C. | Clay ..........cl. | Argile.........A. | Argila ............. | Arcillo or Barro ..... | Lehm ............L. |
| Coral..........Co. | Coral..........crl. | Corail .......Cor. | Corállo ............ | Coral.............cl. | Korallen .........K. |
| Gravel ..........G. | Gravel ..........g. | Gravier ......Gr. | Rena or Ghiaja...... | Cascájo .........Co. | Grob sand ......g. s. |
| Mud ..........M. | Mud ..........m. | Vase .........V. | Fango .............. | Fango or Luno...F. | Schlemm ......Sch. |
| Rocky........rky. | Rock ..........rk. | Roche.........R. | Roccia.............. | Piedra or Roca...P. | Fels ..............F. |
| Sand............S. | Sand........ ..s. | Sable .........S. | Sábia or Aréna ..... | Arena.............A. | Sand.............S. |
| Shells .........Sh. | Shells .........sh. | Coquille ....Coq. | Conchiglia .......... | Conchuela........ca. | Muschel .........M. |
| Stone ..........St. | Stones.........st. | Pierre .........P. | Pietre ............. | Piedra.............P. | Stein. |
| Weed.........Wd. | Weed .........wd. | Herb..........H. | Alga ..............A. | Alga ..............A. | Gras..............G. |
| Fine..........fne. | Fine ...........f. | Fin ..........fin. | Fino................ | Fina ..............f. | Fein ..............f. |
| Coarse ........crs. | Coarse .........c. | Gros ...........g. | Grosso ............. | Gruesa.............. | Grob..............g. |
| Stiff ...........stf. | Stiff ...........stf. | Dure ...........d. | Tenace ............. | Tenaz .............. | Zahe ..............Z. |
| Soft ...........sft. | Soft ...........sft. | Molle .........m. | Molle .............. | Muelle ............. | Weich ...........W. |
| Black .........bk. | Black .........blk. | Noire ..........n. | Nero................ | Negro .............. | Schwarz......schw. |
| Red ...........rd. | Red ...........rd. | Rouge .........r. | Rosse .............. | Rojo................ | Roth. |
| Yellow.........yl. | Yellow .........y. | Jaune..........j. | Giallo .............. | Amarillo ............ | Gelb. |
| Gray ..........gy. | | | | | |

**46.** Measures of Depth.—The following table shows the measures of depth employed in the charts of certain foreign nations, with their equivalents in English measures:

|  | English feet. | English fathoms. |
|---|---|---|
| Austrian ........................................fathom (klafter).. | 6.222 | 1.030 |
| Danish and Norwegian ..........................fathom (farn).. | 6.175 | 1.029 |
| Dutch ..........................................fathom (vaden).. | 5.575 | 0.929 |
| French { fathom (brasse).. | 5.329 | 0.888 |
| French { meter (mètre) ... | 3.281 | 0.547 |
| Portuguese ....................................fathom (braça).. | 6.004 | 1.000 |
| Prussian ......................................fathom (faden).. | 5.906 | 0.984 |
| Russian .......................................fathom (sajen).. | 6.000 | 1.000 |
| Spanish .......................................fathom (braza).. | 5.492 | 0.915 |
| Swedish .......................................fathom (famn).. | 5.843 | 0.974 |

The Dutch *elle*, the Spanish, Portuguese, and Italian *metro*, and the French *mètre* are identical.

A *pied usuel*=13.124 inches, or 1.094 feet. A *mètre* is 3 *pieds;* a *pied du roi*=12.7896 inches; *brasse* is used upon old French charts instead of *mètre*. Upon some Italian charts soundings are in French *pieds*.

## THE BAROMETER.

**47.** The *barometer* is an instrument for measuring the pressure of the atmosphere, and is of great service to the mariner in affording a knowledge of existing meteorological conditions and of the probable changes therein. There are two classes of barometer—*mercurial* and *aneroid*.

**48.** The Mercurial Barometer.—This instrument, invented by Torricelli in 1643, indicates the pressure of the atmosphere by the height of a column of mercury.

If a glass tube of uniform internal diameter somewhat more than 30 inches in length and closed at one end be completely filled with pure mercury, and then placed, open end down, in a cup of mercury (the open end having been temporarily sealed to retain the liquid during the process of inverting), it will be found that the mercury in the tube will fall until the top of the column is about 30 inches above the level of that which is in the cup, leaving in the upper part of the tube a perfect vacuum. Since the weight of the column of mercury thus left standing in the tube is equal to the pressure by which it is held in position—namely, that of the atmospheric air—it follows that the height of the column is subject to variation upon variation of that pressure; hence the mercury falls as the pressure of the atmosphere decreases and rises as that pressure increases. The mean pressure of the atmosphere is equal to nearly 15 pounds to the square inch; the mean height of the barometer is about 30 inches.

**49.** In the practical construction of the barometer the glass tube which contains the mercury is encased in a brass tube, the latter terminating at the top in a ring to be used for suspension, and at the bottom in a flange, to which the several parts forming the cistern are attached. The upper part of the brass tube is partially cut away to expose the mercurial column for observation; abreast this opening is fitted a scale for measuring the height, and along the scale travels a *vernier* for exact reading; the motion of the vernier is controlled by a rack and pinion, the latter having a milled head accessible to the observer, by which the adjustment is made. In the middle of the brass tube is fixed a thermometer, the bulb of which is covered from the outside but open toward the mercury, and which, being nearly in contact with the glass tube, indicates the temperature of the mercury and not that of the external air; the central position of the column is selected in order that the mean temperature may be obtained—a matter of importance, as the temperature of the mercurial column must be taken into account in every accurate application of its reading.

**50.** In the arrangement of further details mercurial barometers are divided into two classes, according as they are to be used as *Standards* (fig. 4) on shore, or as *Sea Barometers* (fig. 3) on shipboard.

In the Standard Barometer the scale and vernier are so graduated as to enable an observer to read the height of the mercurial column to the nearest 0.002 inch, while in the Sea Barometer the reading can not be made closer than 0.01 inch.

The instruments also differ in the method of obtaining the true height of the mercurial column at varying levels of the liquid in the cistern. It is evident that as the mercury in the tube rises, upon increase of atmospheric pressure, the mercury in the cistern must fall; and, conversely, when the mercurial column falls the amount of fluid in the cistern will thereby be increased and a rise of level will occur. As the height of the mercurial column is required above the existing level in the cistern, some means must be adopted to obtain the true height under varying conditions. In the Standard Barometer the mercury of the cistern is contained in a leather bag, against the bottom of which presses the point of a vertical screw, the milled

Fig. 3.

Fig. 4.

head of the screw projecting from the bottom of the instrument and thus placing it under control of the observer. By this means the surface of the mercury in the cistern (which is visible through a glass casing) may be raised or lowered until it exactly coincides with that level which is chosen as the zero of the scale, and which is indicated by an ivory pointer in plain view.

In the Sea Barometer there is no provision for adjusting the level of the cistern to a fixed point, but compensation for the variable level is made in the scale graduations; a division representing an inch on the scale is a certain fraction short of the true inch, proper allowance being thus made for the rise in level which occurs with a fall of the column, and for the reverse condition.

Further modification is made in the Sea Barometer to adapt it to the special use for which intended. The tube toward its lower end is much contracted to prevent the oscillation of the mercurial column known as "pumping," which arises from the motion of the ship; and just below this point is a trap to arrest any small bubbles of air from finding their way upward. The instrument aboard ship is suspended in a revolving center-ring, in gimbals, supported on a horizontal brass arm which is screwed to the bulkhead; a vertical position is thus maintained by the tube at all times.

**51.** The *vernier* is an attachment for facilitating the exact reading of the scale of the barometer, and is also applied to many other instruments of precision, as, for example, the sextant and theodolite. It consists of a metal scale similar in general construction to that of the instrument to which it is fitted, and arranged to move alongside of and in contact with the main scale.

The general principle of the vernier requires that its scale shall have a total length exactly equal to some whole number of divisions of the scale of the instrument and that this length shall be subdivided into a number of parts equal to 1 more or 1 less than the number of divisions of the instrument scale which are covered; thus, if a space of 9 divisions of the main scale be designated as the length of the vernier, the vernier scale would be divided into either 8 or 10 parts.

Suppose that a barometer scale be divided into tenths of an inch and that a length of 9 divisions of such a scale be divided into 10 parts for a vernier (fig. 5); and suppose that the divisions of the vernier be numbered consecutively from zero at the origin to 10 at the upper extremity. If, now, by means of the movable rack and pinion, the bottom or zero division of the vernier be brought level with the top of the mercurial column, and that division falls into exact coincidence with a division of the main scale, then the height of the column will correspond with the scale reading indicated. In such a case the top of the vernier will also exactly coincide with a scale division, but none of the intermediate divisions will be evenly abreast of such a division; the division marked "1" will fall short of a scale division by one-tenth of 1 divison of the scale, or by 0.01 inch; that marked "2" by two-tenths of a division, or 0.02 inch, and so on. If the vernier, instead of having the zero coincide with a scale division, has the division "1" in such coincidence, it follows that the mercurial column stands at 0.01 inch above that scale division which is next below the zero; for the division "2," at 0.02 inch; and similarly for the others. In the case portrayed in figure 5, the reading of the column is 29.81 inches, the scale division next below the zero being 29.80 inches, while the fact that the first division is abreast a mark of the scale shows that 0.01 inch must be added to this to obtain the exact reading.
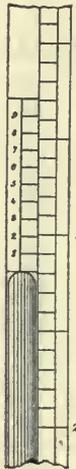
Had an example been chosen in which 8 vernier divisions covered 9 scale divisions—that is, where the number of vernier divisions was 1 less than the number of scale divisions covered—the principle would still have applied. But, instead of the length of 1 division of the vernier falling short of a division of the scale by one-tenth the length of the latter, it would have fallen beyond by one-eighth. To read in such a case it would therefore be necessary to number the vernier divisions from up downward and to regard the subdivisions as $\frac{1}{80}$ instead of 0.01 inch.

It is a general rule that the smallest measure to which a vernier reads is equal to the length of 1 division of the scale divided by the number of divisions of the vernier; hence, by varying either the scale or the vernier, we may arrive at any subdivision that may be desired.

**52.** The Sea Barometer is arranged as described for the instrument assumed in the illustration; the scale divisions are tenths of an inch, and the vernier has 10 divisions, whence it reads to 0.01 inch. It is not necessary to seek a closer reading, as complete accuracy is not attainable in observing the height of a barometer on a vessel at sea, nor is it essential. The Standard Barometer on shore, however, is capable of very exact reading; hence each scale division is made equal to half a tenth, or 0.05 inch, while a vernier covering 24 such divisions is divided into 25 parts; hence the column may be read to 0.002 inch.

**53.** To adjust the vernier for reading the height of the mercurial column the eye should be brought exactly on a level with the top of the column; that is, the line of sight should be at right angles to the scale. When properly set, the front and rear edges of the vernier and the uppermost point of the mercury should all be in the line of sight. A piece of white paper, held at the back of the tube so as to reflect the light, assists in accurately setting the vernier by day, while a small bull's-eye lamp held behind the instrument enables the observer to get a correct reading at night. When observing the barometer it should hang freely, not being inclined by holding or even by touch, because any inclination will cause the column to rise in the tube.

**54.** Other things being equal, the mercury will stand higher in the tube when it is warm than when it is cold, owing to expansion. For the purposes of comparison, all barometric observations are reduced to a standard which assumes 32° F. as the temperature of the mercurial column, and 62° F. as that of the metal scale; it is therefore important to make this reduction, as well as that for instrumental error (art. 56), in order to be enabled to compare the true barometric pressure with the normal that may be expected for any locality. The following table gives the value of this correction for each 2° F.,

FIG. 5.

the plus sign showing that the correction is to be added to the reading of the ship's barometer and the minus sign that it is to be subtracted:

| Temperature. | Correction. | Temperature. | Correction. | Temperature. | Correction. | Temperature. | Correction. |
|---|---|---|---|---|---|---|---|
| ° | Inch. | ° | Inch. | ° | Inch. | ° | Inch. |
| 20 | +0. 02 | 40 | −0. 03 | 60 | −0. 09 | 80 | −0. 14 |
| 22 | +0. 02 | 42 | −0. 04 | 62 | −0. 09 | 82 | −0. 14 |
| 24 | +0. 01 | 44 | −0. 04 | 64 | −0. 09 | 84 | −0. 15 |
| 26 | +0. 01 | 46 | −0. 05 | 66 | −0. 10 | 86 | −0. 15 |
| 28 | 0. 00 | 48 | −0. 05 | 68 | −0. 10 | 88 | −0. 16 |
| 30 | 0. 00 | 50 | −0. 06 | 70 | −0. 11 | 90 | −0. 16 |
| 32 | −0. 01 | 52 | −0. 06 | 72 | −0. 12 | 92 | −0. 17 |
| 34 | −0. 02 | 54 | −0. 07 | 74 | −0. 12 | 94 | −0. 17 |
| 36 | −0. 02 | 56 | −0. 07 | 76 | −0. 13 | 96 | −0. 18 |
| 38 | −0. 03 | 58 | −0. 08 | 78 | −0. 13 | 98 | −0. 18 |

As an example, let the observed reading of the mercurial barometer be 29.95 inches, and the temperature as given by the attached thermometer 74°; then we have:

```
Observed height of the mercury ............................. .......... 29. 95
Correction for temperature (74°) ................................... −0. 12

Height of the mercury at standard temperature ..................... 29. 83
```

**55.** The Aneroid Barometer.—This is an instrument in which the pressure of the air is measured by means of the elasticity of a plate of metal. It consists of a cylindrical brass box, the metal in the sides being very thin; the contained air having been partially, though not completely, exhausted, the box is hermetically sealed. When the pressure of the atmosphere increases the inclosed air is compressed, the capacity of the box is diminished, and the two flat ends approach each other; when the pressure of the atmosphere decreases, the ends recede from one another in consequence of the expansion of the inclosed air. By means of a combination of levers, this motion of the ends of the box is communicated to an index pointer which travels over a graduated dial plate, the mechanical arrangement being such that the motion of the ends of the box is magnified many times, a very minute movement of the box making a considerable difference in the indication of the pointer. The graduations of the aneroid scale are obtained by comparison with the correct readings of a standard mercurial barometer under normal and reduced atmospheric pressure.

The thermometer attached to the aneroid barometer is merely for convenience in indicating the temperature of the air, but as regards the instrument itself, no correction for temperature can be applied with certainty. Aneroids, as now manufactured, are almost perfectly compensated for temperature by the use of different metals having unequal coefficients of expansion; they ought, therefore, to show the same pressure at all temperatures.

The aneroid barometer, from its small size and the ease with which it may be transported, can often be usefully employed under circumstances where a mercurial barometer would not be available. It also has an advantage over the mercurial instrument in its greater sensitiveness, and the fact that it gives earlier indications of change of pressure. It can, however, be relied upon only when frequently compared with a standard mercurial barometer; moreover, considerable care is required in its handling; while slight shocks will not ordinarily affect it, a severe jar or knock may change its indications by a large amount.

When in use the aneroid barometer may be suspended vertically or placed flat, but changing from one position to another ordinarily makes a sensible change in the readings; the instrument should always, therefore, be kept in the same position, and the errors determined by comparisons made while occupying its customary place.

**56.** Comparison of Barometers.—To determine the reliability of the ship's barometer, whether mercurial or aneroid, comparisons should from time to time be made with a standard barometer. Nearly all instruments read either too high or too low by a small amount. These errors arise, in a mercurial barometer, from the improper placing of the scale, lack of uniformity of caliber of the glass tube, or similar causes; in an aneroid, which is less accurate and in which there is even more necessity for frequent comparisons, errors may be due to derangement of any of the various mechanical features upon which its working depends. The errors of the barometer should be determined for various heights, as they are seldom the same at all parts of the scale.

In the principal ports of the world standard barometers are observed at specified times each day, and the readings, reduced to zero and to sea level, are published. It is therefore only necessary to read the barometer on shipboard at those times, and, if a mercurial instrument is used, to note the attached thermometer and apply the correction for temperature (art. 54). It is evident that a comparison of the heights by reduced standard and by the ship's barometer will give the correction to be applied to the latter, including the instrumental error, the reduction to sea level, and the personal error of the observer. In the United States, standard barometer readings are made by the Weather Bureau and Branch Hydrographic offices.

Aneroid barometers may be adjusted for instrumental error by moving the index hand, but this is usually done only in the case of errors of considerable magnitude.

**57.** Determination of Heights by Barometer.—The barometer may be used to determine the difference in heights between any two stations by means of the difference in atmospheric pressure

between them.    An approximate rule is to allow 0.0011 inch for each difference in level of one foot, or, more roughly, 0.01 inch for every 9 feet.

A very exact method is afforded by Babinet's formula.    If $B_0$ and B represent the barometric pressure (corrected for all sources of instrumental error) at the lower and at the upper stations respectively, and $t_0$ and $t$ the corresponding temperatures of the air; then,

$$\text{Diff. in height} = C \times \frac{B_0 - B}{B_\bullet + B};$$

if the temperatures be taken by a Farhenheit thermometer,

$$C \text{ (in feet)} = 52,494 \left( 1 + \frac{t_0 + t - 64}{900} \right);$$

if a centigrade thermometer is used,

$$C \text{ (in meters)} = 16,000 \left( 1 + \frac{2(t_0 + t)}{1000} \right).$$

## THE THERMOMETER.

**58.** The *Thermometer* is an instrument for indicating temperature.    In its construction advantage is taken of the fact that bodies are expanded by heat and contracted by cold.    In its most usual form the thermometer consists of a bulb filled with mercury, connected with a tube of very fine cross-sectional area, the liquid column rising or falling in the tube according to the volume of the mercury due to the actual degree of heat, and the height of the mercury indicating upon a scale the temperature; the mercury contained in the tube moves in a vacuum produced by the expulsion of the air through boiling the mercury and then closing the top of the tube by means of the blowpipe.

There are three classes of thermometer, distinguished according to the method of graduating the scale as follows: the *Fahrenheit*, in which the freezing point of water is placed at 32° and its boiling point (under normal atmospheric pressure) at 212°; the *Centigrade*, in which the freezing point is at 0° and the boiling point at 100°; and the *Réaumur*, in which these points are at 0° and 80°, respectively. The Fahrenheit thermometer is generally used in the United States and England.    Tables will be found in this work for the interconversion of the various scale readings (Table 31).

**59.** The thermometer is a valuable instrument for the mariner, not only by reason of the aid it affords him in judging meteorological conditions from the temperature of the air and the amount of moisture it contains, but also for the evidences it furnishes at times, through the temperature of the sea water, of the ship's position and the probable current that is being encountered.

**60.** The thermometers employed in determining the temperature of the air (wet and dry bulb) and of the water at the surface, should be mercurial, and of some standard make, with the graduation etched upon the glass stem; they should be compared with accurate standards, and not accepted if their readings vary more than 1° from the true at any point of the scale.

**61.** The dry-bulb thermometer gives the temperature of the free air.    The wet-bulb thermometer, an exactly similar instrument the bulb of which is surrounded by an envelope of moistened cloth, gives what is known as the *temperature of evaporation*, which is always somewhat less than the temperature of the free air.    From the difference of these two temperatures the observer may determine the proximity of the air to saturation; that is, how near the air is to that point at which it will be obliged to precipitate some of its moisture (water vapor) in the form of liquid.    With the envelope of the wet bulb removed, the two thermometers should read precisely the same; otherwise they are practically useless.

The two thermometers, the wet and the dry bulb, should be hung within a few inches of each other, and the surroundings should be as far as possible identical. In practice the two thermometers are generally inclosed within a small lattice case, such as that shown in figure 6; the case should be placed in a position on deck remote from any source of artificial heat, sheltered from the direct rays of the sun, and from the rain and spray, but freely exposed to the circulation of the air; the door should be kept closed except during the process of reading.    The cloth envelope of the wet bulb should be a single thickness of fine muslin, tightly stretched over the bulb, and tied with a fine thread. The wick which serves to carry the water from the cistern to the bulb should consist of a few threads of
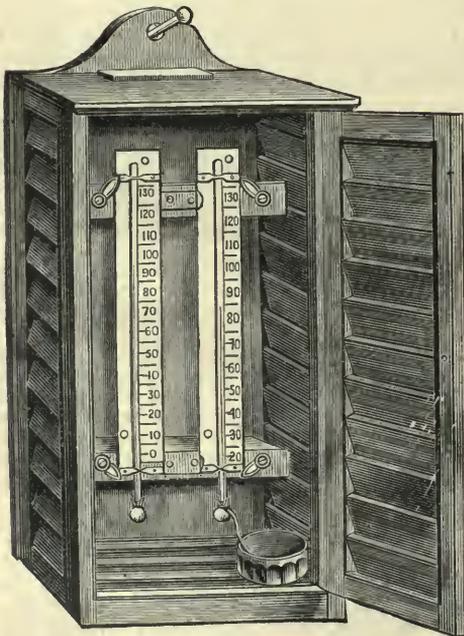


FIG. 6.

lamp cotton, and should be of sufficient length to admit of two or three inches being coiled in the cistern. The muslin envelope of the wet bulb should be at all times thoroughly moist, but not dripping.

When the temperature of the air falls to 32° F. the water in the wick freezes, the capillary action is at an end, the bulb in consequence soon becomes quite dry, and the thermometer no longer shows the temperature of evaporation.    At such times the bulb should be thoroughly wetted with ice-cold water shortly before the time of observation, using for this purpose a camel's hair brush or feather; by

this process the temperature of the wet bulb is temporarily raised above that of the dry, but only for a brief time, as the water quickly freezes; and inasmuch as evaporation takes place from the surface of the ice thus formed precisely as from the surface of the water, the thermometer will act in the same way as if it had a damp bulb. The wet-bulb thermometer can not properly read higher than the dry, and if the reading of the wet bulb should be the higher, it may always be attributed to imperfections in the instruments.

**62.** Knowing the temperature of the wet and dry bulbs, the relative humidity of the atmosphere at the time of observation may be found from the following table:

| Temperature of the air, dry-bulb thermometer. | Difference between dry-bulb and wet-bulb readings. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° |
| ° | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. |
| 24 | 87 | 75 | 62 | 50 | 38 | 26 | | | | |
| 26 | 88 | 76 | 65 | 53 | 42 | 30 | | | | |
| 28 | 89 | 78 | 67 | 56 | 45 | 34 | 24 | | | |
| 30 | 90 | 79 | 68 | 58 | 48 | 38 | 28 | | | |
| 32 | 90 | 80 | 70 | 61 | 51 | 41 | 32 | 23 | | |
| 34 | 90 | 81 | 72 | 63 | 53 | 44 | 35 | 27 | | |
| 36 | 91 | 82 | 73 | 64 | 55 | 47 | 38 | 30 | 22 | |
| 38 | 92 | 83 | 75 | 66 | 57 | 50 | 42 | 34 | 26 | |
| 40 | 92 | 84 | 76 | 68 | 59 | 52 | 44 | 37 | 30 | 22 |
| 42 | 92 | 84 | 77 | 69 | 61 | 54 | 47 | 40 | 33 | 26 |
| 44 | 92 | 85 | 78 | 70 | 63 | 56 | 49 | 43 | 36 | 29 |
| 46 | 93 | 85 | 79 | 72 | 65 | 58 | 51 | 45 | 38 | 32 |
| 48 | 93 | 86 | 79 | 73 | 66 | 60 | 53 | 47 | 41 | 35 |
| 50 | 93 | 87 | 80 | 74 | 67 | 61 | 55 | 49 | 43 | 37 |
| 52 | 94 | 87 | 81 | 75 | 69 | 63 | 57 | 51 | 46 | 40 |
| 54 | 94 | 88 | 82 | 76 | 70 | 64 | 59 | 53 | 48 | 42 |
| 56 | 94 | 88 | 82 | 77 | 71 | 65 | 60 | 55 | 50 | 44 |
| 58 | 94 | 89 | 83 | 78 | 72 | 67 | 61 | 56 | 51 | 46 |
| 60 | 94 | 89 | 84 | 78 | 73 | 68 | 63 | 58 | 53 | 48 |
| 62 | 95 | 89 | 84 | 79 | 74 | 69 | 64 | 59 | 54 | 50 |
| 64 | 95 | 90 | 85 | 79 | 74 | 70 | 65 | 60 | 56 | 51 |
| 66 | 95 | 90 | 85 | 80 | 75 | 71 | 66 | 61 | 57 | 53 |
| 68 | 95 | 90 | 85 | 81 | 76 | 71 | 67 | 63 | 58 | 54 |
| 70 | 95 | 90 | 86 | 81 | 77 | 72 | 68 | 64 | 60 | 55 |
| 72 | 95 | 91 | 86 | 82 | 77 | 73 | 69 | 65 | 61 | 57 |
| 74 | 95 | 91 | 86 | 82 | 78 | 74 | 70 | 66 | 62 | 58 |
| 76 | 95 | 91 | 87 | 82 | 78 | 74 | 70 | 66 | 63 | 59 |
| 78 | 96 | 91 | 87 | 83 | 79 | 75 | 71 | 67 | 63 | 60 |
| 80 | 96 | 92 | 87 | 83 | 79 | 75 | 72 | 68 | 64 | 61 |
| 82 | 96 | 92 | 88 | 84 | 80 | 76 | 72 | 69 | 65 | 62 |
| 84 | 96 | 92 | 88 | 84 | 80 | 77 | 73 | 69 | 66 | 63 |
| 86 | 96 | 92 | 88 | 84 | 81 | 77 | 73 | 70 | 67 | 63 |
| 88 | 96 | 92 | 88 | 85 | 81 | 77 | 74 | 71 | 67 | 64 |
| 90 | 96 | 92 | 88 | 85 | 81 | 78 | 74 | 71 | 68 | 65 |

The table may be readily understood. For example, if the temperature of the air (dry bulb) be 60°, and the temperature of evaporation (wet bulb) be 56°, the difference being 4°, look in the column headed "Temperature of the air" for 60°, and for the figures on the same line in column headed 4°; here 78 will be found, which means that the air is 78 per cent saturated with water vapor; that is, that the amount of water vapor present in the atmosphere is 78 per cent of the total amount that it could carry at the given temperature (60°). This total amount, or saturation, is thus represented by 100, and if there occurred any increase of the quantity of vapor beyond this point, the excess would be precipitated in the form of liquid. Over the ocean's surface the relative humidity is generally about 90 per cent, or even higher in the doldrums; over the land in dry winter weather it may fall as low as 40 per cent.

**63.** The sea water of which the temperature is to be taken should be drawn from a depth of 3 feet below the surface, the bucket used being weighted in order to sink it. The bulb of the thermometer should remain immersed in the water at least three minutes before reading, and the reading should be made with the bulb immersed.

### THE LOG BOOK.

**64.** The *Log Book* is a record of the ship's cruise, and, as such, an important accessory in the navigation. It should afford all the data from which the position of the ship is established by the method of dead reckoning; it should also comprise a record of meteorological observations, which should be made not only for the purpose of foretelling the weather during the voyage, but also for contribution to the general fund of knowledge of marine meteorology.

**65.** A convenient form for recording the data, which is employed for the log books of United States naval vessels, is shown on page 26; beside the tabulated matter thus arranged, to which one page of the book is devoted, a narrative of the miscellaneous events of the day, written and signed by the proper officers, appears upon the opposite page.

| Hour. | Speed. | | Reading of patent log. | Course steered by standard compass. | Wind. | | Heel. | Lee-way. | Barometer. | | Temperature. | | | State of weather by symbols. | Clouds. | | | Amount, scale 0 to 10. | State of sea by symbols. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Knots. | Tenths. | | | Direction by standard compass. | Force. | | | Height in inches. | Thermometer attd. | Air, dry bulb. | Air, wet bulb. | Water at surface. | | Form by symbols. | Moving from. | | | |
| A. M. | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | |
| Etc. | | | | | | | | | | | | | | | | | | | |

Position at 8.00 a. m. { Lat. by ..... °   ′   ″
                      { Long. by .....

Position at noon { Lat. by Obs. .....
                { Long. by Obs .....
                { Lat. by D. R. .....
                { Long. by D. R. .....

Course made good since preceding noon ..... true.
Distance made good since preceding noon ..... knots.
Distance by log since preceding noon ..... knots.
Current per hour ..... knots; setting ......... true.

Position at 8.00 p. m. { Lat. by ..... °
                      { Long. by .....

Variation of compass .....
Error of compass observed at .....
Deviation of compass on .....
Water expended during preceding 24 hrs ..... gals.
Water ...... during preceding 24 hrs ..... gals.
Water remaining on hand fit for use at noon ..... gals.
Coal consumed during preceding 24 hrs ..... tons.
Coal remaining on hand at noon ..... tons.

**66.** For the most part, the nature of the information called for, with the method of recording it, will be apparent. A brief explanation is here given of such points as seem to require it.

**67.** THE WIND.—In recording the force of the wind the scale devised by the late Admiral Sir F. Beaufort is employed. According to this scale the wind varies from 0, a calm, to 12, a hurricane, the greatest velocity it ever attains. In the lower grades of the scale the force of the wind is estimated from the speed imparted to a man-of-war of the early part of the nineteenth century sailing full and by; in the higher grades, from the amount of sail which the same vessel could carry when closehauled. The scale, with the estimated velocity of the wind in both statute and nautical miles per hour, is as follows:

| Force of wind. | Conditions. | Velocity. | | Mean pressure in pounds per square foot. |
|---|---|---|---|---|
| | | Statute miles per hour. | Nautical miles per hour. | |
| 0.—Calm............. | Full-rigged ship, all sails set, no headway. | 0 to 3 | 0 to 2.6 | 0.03 |
| 1.—Light air.......... | Just sufficient to give steerage way....... | 8 | 6.9 | 0.23 |
| 2.—Light breeze...... | Speed of 1 or 2 knots, "full and by"...... | 13 | 11.3 | 0.62 |
| 3.—Gentle breeze..... | Speed of 3 or 4 knots, "full and by"...... | 18 | 15.6 | 1.2 |
| 4.—Moderate breeze.. | Speed of 5 or 6 knots, "full and by"...... | 23 | 20.0 | 1.9 |
| 5.—Fresh breeze...... | All plain sail, "full and by"............. | 28 | 24.3 | 2.9 |
| 6.—Strong breeze..... | Topgallantsails over single-reefed topsails | 34 | 29.5 | 4.2 |
| 7.—Moderate gale .... | Double-reefed topsails................... | 40 | 34.7 | 5.9 |
| 8.—Fresh gale ........ | Treble-reefed topsails (or reefed upper-topsails and courses). | 48 | 41.6 | 8.4 |
| 9.—Strong gale ....... | Close-reefed topsails and courses (or lower topsails and courses). | 56 | 48.6 | 11.5 |
| 10.—Whole gale ....... | Close-reefed main topsail and reefed fore-sail (or lower main topsail and reefed foresail). | 65 | 56.4 | 15.5 |
| 11.—Storm............. | Storm staysails ........................... | 75 | 65.1 | 20.6 |
| 12.—Hurricane ........ | Under bare poles ......................... | 90 and over. | 78.1 and over. | 29.6 |

**68.** When steaming or sailing with any considerable speed, the apparent direction and force of the wind, as determined from a vane, flag, or pennant aboard ship, may differ materially from the true direction and force, the reason being that the air appears to come from a direction and with a force dependent, not only upon the wind itself, but also upon the motion of the vessel. For instance, suppose that the wind has a velocity of 20 knots an hour (force 4), and take the case of two vessels, each steaming 20 knots, the first with the wind dead aft, the second with the wind dead ahead. The former vessel will be moving with the same velocity as the air and in the same direction; the velocity of the wind relatively to the ship will thus be zero; on the vessel an apparent calm will prevail and the pennant will hang up and down. The latter vessel will be moving with the same velocity as the air, but in the opposite direction; the relative velocity of the two will thus be the sum of the two velocities, or 40 knots an hour, and on the second vessel the wind will apparently have the velocity corresponding very nearly with a fresh gale. Again, it might be shown that in the case of a vessel steaming west at the rate of 20 knots, with the wind blowing from north with the velocity of 20 knots an hour, the velocity with which the air strikes the ship as a result of the combined motion will be 28 knots an hour, and the direction from which it comes will be NW. If, therefore, the effect of the speed of the ship is neglected the wind will be recorded as NW., force 6, when in reality it is north, force 4.

In order to make a proper allowance for this error and arrive at the true direction and force of the wind, Table 32 may be entered with the ship's speed and the apparent direction and force of the wind as arguments, and the true direction and force will be found.

**69.** WEATHER.—To designate the weather a series of symbols devised by the late Admiral Beaufort is employed. The system is as follows:

*b.*—Clear blue sky.
*c.*—Clouds.
*d.*—Drizzling, or light rain.
*f.*—Fog, or foggy weather.
*g.*—Gloomy, or dark, stormy-looking weather.
*h.*—Hail.
*l.*—Lightning.
*m.*—Misty weather.
*o.*—Overcast.

*p.*—Passing showers of rain.
*q.*—Squally weather.
*r.*—Rainy weather, or continuous rain.
*s.*—Snow, or snowy weather.
*t.*—Thunder.
*u.*—Ugly appearances, or threatening weather.
*v.*—Visibility of distant objects.
*w.*—Wet, or heavy dew.
*z.*—Hazy.

To indicate great intensity of any feature, its symbol may be underlined; thus: *r.*, heavy rain.

**70.** CLOUDS.—The following are the principal forms of clouds, named in the order of the altitude above the earth at which they usually occur, beginning with the most elevated. The symbols by which each is designated follows its name:

1. CIRRUS, (*Ci.*).—Detached clouds, delicate and fibrous looking, taking the form of feathers, generally of a white color, sometimes arranged in belts which cross a portion of the sky in great circles, and, by an effect of perspective, converging toward one or two opposite points of the horizon.

2. CIRRO-STRATUS, (*Ci.-S.*).—A thin, whitish sheet, sometimes completely covering the sky and only giving it a whitish appearance, or at others presenting, more or less distinctly, a formation like a tangled web. This sheet often produces halos around the sun and moon.

3. CIRRO-CUMULUS, (*Ci.-Cu.*).—Small globular masses or white flakes, having no shadows, or only very slight shadows, arranged in groups and often in lines.

4. ALTO-CUMULUS, (*A.-Cu.*).—Rather large globular masses, white or grayish, partially shaded, arranged in groups or lines, and often so closely packed that their edges appear confused. The detached masses are generally larger and more compact at the center of the group; at the margin they form into finer flakes. They often spread themselves out in lines in one or two directions.

5. ALTO-STRATUS, (*A.-S.*).—A thick sheet of a gray or bluish color, showing a brilliant patch in the neighborhood of the sun or moon, and which, without causing halos, may give rise to coronæ. This form goes through all the changes like the Cirro-Stratus, but its altitude is only half so great.

6. STRATO-CUMULUS, (*S.-Cu.*).—Large globular masses or rolls of dark cloud, frequently covering the whole sky, especially in winter, and occasionally giving it a wavy appearance. The layer of Strato-Cumulus is not, as a rule, very thick, and patches of blue sky are often visible through the intervening spaces. All sorts of transitions between this form and the Alto-Cumulus are noticeable. It may be distinguished from Nimbus by its globular or rolled appearance and also because it does not bring rain.

7. NIMBUS, (*N.*).—Rain clouds; a thick layer of dark clouds, without shape and with ragged edges, from which continued rain or snow generally falls. Through the openings of these clouds an upper layer of Cirro-Stratus or Alto-Stratus may almost invariably be seen. If the layer of Nimbus separates into shreds or if small loose clouds are visible floating at a low level underneath a large nimbus, they may be described as Fracto-Nimbus (Fr.-N.), the "scud" of sailors.

8. CUMULUS, (*Cu.*).—Wool-pack clouds; thick clouds of which the upper surface is dome-shaped and exhibits protuberances, while the base is horizontal. When these clouds are opposite the sun the surfaces usually presented to the observer have a greater brilliance than the margins of the protuberances. When the light falls aslant, they give deep shadows; when, on the contrary, the clouds are on the same side as the sun, they appear dark, with bright edges. The true Cumulus has clear superior and inferior limits. It is often broken up by strong winds, and the detached portions undergo continual changes. These may be distinguished by the name of Fracto-Cumulus (*Fr.-Cu.*).

9. CUMULO-NIMBUS, (*Cu.-N.*).—The thunder-cloud or shower-cloud; heavy masses of clouds rising in the form of mountains, turrets, or anvils, generally having a sheet or screen of fibrous appearance above, and a mass of clouds similar to Nimbus underneath. From the base there usually fall local showers of rain or of snow (occasionally hail or soft hail).

10. STRATUS, (*S.*).—A horizontal sheet of lifted fog; when this sheet is broken up into irregular shreds by the wind or by the summits of mountains, it may be distinguished by the name of Fracto-Stratus (*Fr.-S.*).

**71.** In the scale for the amount of clouds 0 represents a sky which is cloudless and 10 a sky which is completely overcast.

**72.** STATE OF SEA.—The state of the sea is expressed by the following system of symbols:

| | |
|---|---|
| B.—Broken or irregular sea. | M.—Moderate sea or swell. |
| C.—Chopping, short, or cross sea. | R.—Rough sea. |
| G.—Ground swell. | S.—Smooth sea. |
| H.—Heavy sea. | T.—Tide-rips. |
| L.—Long rolling sea. | |

# CHAPTER III

# THE COMPASS ERROR.

## CAUSES OF THE ERROR.

**73.** When two magnets are near enough together to exert a mutual influence, their properties are such as to cause those poles which possess similar magnetism to repel, and those which possess magnetism of opposite sorts to attract one another.

The earth is an immense natural magnet, having in each hemisphere a pole lying in the neighborhood of the geographical pole, though not exactly coincident therewith; consequently, when a magnet, such as that of a compass, is allowed to revolve freely in a horizontal plane, it will so place itself as to be parallel to the lines of magnetic force in that plane created by the earth's magnetic poles, the end which we name north pointing to the north, and the south end in the opposite direction. The north end of the compass—north-seeking, as it is sometimes designated for clearness—will be that end which has opposite polarity to the earth's north magnetic pole, this latter possessing the same sort of magnetism as the so-called south pole of the compass.

**74.** By reason of the fact that the magnetic pole differs in position from the geographical pole, the compass needle will not indicate true directions, but each compass point will differ from the corresponding true point by an amount dependent upon the angle between the geographical and the magnetic pole at the position of the observer. The amount of this difference, expressed in angular measure, is the *Variation of the Compass* (sometimes called also the *Declination*, though this term is seldom employed by navigators).

The variation not only changes as one travels from point to point on the earth, being different in different localities, but, as it has been found that the earth's magnetic poles are in constant motion, it undergoes certain changes from year to year. In taking account of the error it produces, the navigator must therefore be sure that the variation used is correct not only for the *place*, but also for the *time* under consideration. The variation is subject to a small diurnal fluctuation, but this is not a material consideration with the mariner.

**75.** Besides the error thus produced in the indications of the compass, a further one, due to *Local Attraction*, may arise from extraneous influences due to natural magnetic attraction in the vicinity of the vessel. Instances of this are quite common when a ship is in port, as she may be in close proximity to vessels, docks, machinery, or other masses of iron or steel. It is also encountered at sea in localities where the mineral substances in the earth itself possess magnetic qualities—as, for example, at certain places in Lake Superior and at others off the coast of Australia. When due to the last-named cause, it may be a source of great danger to the mariner, but, fortunately, the number of localities subject to local attraction is limited. The amount of this error can seldom, if ever, be determined; if known, it might properly be included with the variation and treated as a part thereof.

**76.** In addition to the variation, the compass ordinarily has a still further error in its indications, which arises from the effect exerted upon it by masses of magnetic metal within the ship itself. This is known as the *Deviation of the Compass*. For reasons that will be explained later, it differs in amount for each heading of the ship, and, further, the character of the deviations undergo modification as a vessel proceeds from one geographical locality to another.

## APPLYING THE COMPASS ERROR.

**77.** From what has been explained, it may be seen that there are three methods by which bearings or courses may be expressed: (*a*) *true*, when they refer to the angular distance from the earth's geographical meridian; (*b*) *magnetic*, when they refer to the angular distance from the earth's magnetic meridian, and must be corrected for variation to be converted into true; and (*c*) *by compass*, when they refer to the angular distance from the north indicated by the compass on a given heading of the ship, and must be corrected for the deviation on that heading for conversion to magnetic, and for both deviation and variation for conversion to true bearings or courses. The process of applying the errors under all circumstances is one of which the navigator must make himself a thorough master; the various problems of conversion are constantly arising; no course can be set nor bearing plotted without involving the application of this problem, and a mistake in its solution may produce serious consequences. The student is therefore urged to give it his most careful attention.

**78.** When the effect of a compass error, whether arising from variation or from deviation, is to draw the north end of the compass needle to the right, or eastward, the error is named *east*, or is marked +; when its effect is to draw the north end of the needle to the left or westward, it is named *west*, or marked —.

Figures 7 and 8 represent, respectively, examples of easterly and westerly errors. In both cases consider that the circles represent the observer's horizon, N and S being the correct north and south points in each case. If N′ and S′ represent the corresponding points indicated by a compass whose needle is deflected by a compass error, then in the first case, the north end of the needle being drawn to the right or east, the error will be easterly or positive, and in the second case, the north end of the needle being drawn to the left or west, the compass error will be westerly or negative.
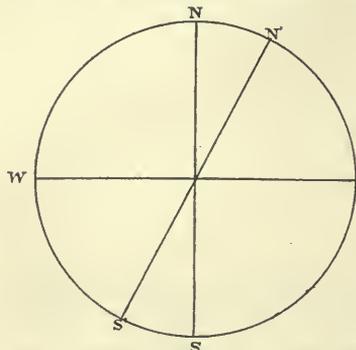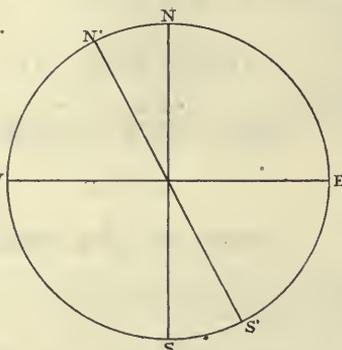
FIG. 7.            FIG. 8.

Considering figure 7, if we assume the easterly error to amount to one point, it will be seen that if a direction of N. by W. is indicated by the compass, the correct direction should be north, or one point farther to the right. If the compass indicates north, the correct bearing is N. by E.; that is, still one point to the right. If we follow around the whole card, the same relation will be found in every case, the corrected bearing being always one point to the right of the compass bearing. Conversely, if we regard figure 8, assuming the same amount of westerly error, a compass bearing of N. by E. is the equivalent of a correct bearing of north, which is one point to the left; and this rule is general throughout the circle, the corrected direction being always to the left of that shown by the compass.

**79.** Having once satisfied himself that the general rule holds, the navigator may save the necessity of reasoning out in each case the direction in which the error must be applied, and need only charge his mind with some single formula which will cover all cases. Such a one is the following:

*When the* CORRECT *direction is to the* RIGHT, *the error is* EAST.

The words *correct-right-east*, in such a case, would be the key to all of his solutions. If he had a compass course to change to a corrected one with easterly deviation, he would know that to obtain the result the error must be applied to the right; if it were desired to change a correct course to the one indicated by compass, the error being westerly, the converse presents itself—the correct must be to the left—the uncorrected will therefore be to the right; if a correct bearing is to be compared with a compass bearing to find the compass error, when the correct is to the right the error is east, or the reverse.

**80.** It must be remembered that the word *east* is equivalent to *right* in dealing with the compass error, and *west* to *left*, even though they involve an apparent departure from the usual rules. If a vessel steers NE. by compass with one point easterly error, her corrected course is NE. by E.; but if she steers SE., the corrected course is not SE. by E., but SE. by S. Another caution may be necessary to avoid confusion; the navigator should always regard himself as facing the point under consideration when he applies an error; one point westerly error on South will bring a corrected direction to S. by E.; but if we applied one point to the left of South while looking at the compass card in the usual way—north end up—S. by W. would be the point arrived at, and a mistake of two points would be the result.

**81.** In the foregoing explanation reference has been made to "correct" directions and "compass errors" without specifying "magnetic" and "true" or "variation" and "deviation." This has been done in order to make the statements apply to all cases and to enable the student to grasp the subject in its general bearing without confusion of details.

Actually, as has already been pointed out, directions given may be true, magnetic, or by compass. By applying variation to a magnetic bearing we correct it and make it true, by applying deviation to a compass bearing we correct it to magnetic, and by applying to it the combined deviation and variation we correct it to true. Whichever of these operations is undertaken, and whichever of the errors is considered, the process of correction remains the same; the correct direction is always to the right, when the error is east, by the amount of that error.

Careful study of the following examples will aid in making the subject clear:

EXAMPLES: A bearing taken by a compass free from deviation is N. 76° E.; variation, 5° W.; required the true bearing. N. 71° E.

A bearing taken by a similar compass is NW. by W. ½ W.; variation, ¼ pt. W.; required the true bearing. NW. by W. ¾ W.

A vessel steers S. 27° E. by compass; deviation on that heading, 3° W.; variation in the locality, 12° E.; required the true course. S. 18° E.

A vessel steers S. by W. ½ W.; deviation, ¼ pt. W.; variation, 1 pt. E.; required the true course. SSW. ¼ W.

It is desired to steer the magnetic course N. 38° W.; deviation, 4° E.; required the course by compass. N. 42° W.

The true course between two points is found to be W. ⅞ N.; variation 1¼ pt. E.; no deviation; required the compass course. W. ⅜ S.

True course to be made, N. 55° E.; deviation, 7° E.; variation, 14° W.; required the course by compass. N. 62° E.

A vessel passing a range whose direction is known to be S. 20° W., magnetic, observes the bearing by compass to be S. 2° E.; required the deviation. 22° E.

The sun's observed bearing by compass is S. 89° E.; it is found by calculation to be N. 84° E. (true); variation, 8° W.; required the deviation. 1° E.

## FINDING THE COMPASS ERROR.

**82.** The variation of the compass for any given locality is found from the charts. A nautical chart always contains information from which the navigator is enabled to ascertain the variation for any place within the region embraced and for any year. Beside the information thus to be acquired from local charts, special charts are published showing the variation at all points on the earth's surface.

**83.** The deviation of the compass, varying as it does for every ship, for every heading, and for every geographical locality, must be determined by the navigator, for which purpose various methods are available.

Whatever method is used, the ship must be swung in azimuth and an observation made on each of the headings upon which the deviation is required to be known. If a new iron or steel ship is being swung for the first time, observations should be made on each of the thirty-two points. At later swings, especially after correctors have been applied, or in the case of wooden ships, sixteen points will suffice—or, indeed, only eight. In case it is not practicable to make observations on exact compass points, they should be made as near thereto as practicable and platted on the Napier diagram (to be explained hereafter), whence the deviations on exact points may be found.

**84.** In swinging ship for deviations the vessel should be on an even keel and all movable masses of iron in the vicinity of the compass secured as for sea. The vessel, upon being placed on any heading, should be steadied there for three to four minutes before the observation is made in order that the compass card may come to rest and the magnetic conditions assume a settled state. To assure the greatest accuracy the ship should first be swung to starboard, then to port, and the mean of the two deviations on each course taken. Ships may be swung under their own steam, or with the assistance of a tug, or at anchor, where the action of the tide tends to turn them in azimuth (though in this case it is difficult to get them steadied for the requisite time on each heading), or at anchor, by means of springs and hawsers.

**85.** The deviation of all compasses on the ship may be obtained from the same swing, it being required to make observations with the standard only. To accomplish this it is necessary to record the ship's head by all compasses at the time of steadying on each even point of the standard; applying the deviation, as ascertained, to the heading by standard, gives the magnetic heads, with which the direction of the ship's head by each other compass may be compared, and the deviation thus obtained. Then a complete table of deviations may be constructed as explained in article 94.

**86.** There are four methods for ascertaining the deviations from swinging; namely, by *reciprocal bearings*, by *bearings of the sun*, by *ranges*, and by a *distant object*.

**87.** RECIPROCAL BEARINGS.—One observer is stationed on shore with a spare compass placed in a position free from disturbing magnetic influences; a second observer is at the standard compass on board ship. At the instant when ready for observation a signal is made, and each notes the bearing of the other. The bearing by the shore compass, reversed, is the magnetic bearing of the shore station from the ship, and the difference between this and the bearing by the ship's standard compass represents the deviation of the latter.

In determining the deviations of compasses placed on the fore-and-aft amidship line, when the distribution of magnetic metal to starboard and port is symmetrical, the shore compass may be replaced by a dumb compass, or pelorus, or by a theodolite in which, for convenience, the zero of the horizontal graduated circle may be termed north; the reading of the shore instrument will, of course, not represent magnetic directions, but by assuming that they do we obtain a series of fictitious deviations, the mean value of which is the error common to all. Upon deducting this error from each of the fictitious deviations, we obtain the correct values.

If ship and shore observers are provided with watches which have been compared with one another, the times may be noted at each observation, and thus afford a means of locating errors due to misunderstanding of signals.

**88.** BEARINGS OF THE SUN.—In this method it is required that on each heading a bearing of the sun be observed by compass and the time noted at the same moment by a chronometer or watch. By means which will be explained in Chapter XIV, the true bearing of the sun may be ascertained from the known data, and this, compared with the compass bearing, gives the total compass error; deducting from the compass error the variation, there remains the deviation. The variation used may be that given by the chart, or, in the case of a compass affected only by symmetrically placed iron or steel, may be considered equal to the mean of all the total errors. Other celestial bodies may be observed for this purpose in the same manner as the sun.

This method is important as being the only one available for determining the compass error at sea.

**89.** RANGES.—In many localities there are to be found natural or artificial range marks which are clearly distinguishable, and which when in line lie on a known magnetic bearing. By steaming about on different headings and noting the compass bearing of the ranges each time of crossing the line that they mark, a series of deviations may be obtained, the deviation of each heading being equal to the difference between the compass and the magnetic bearing.

**90.** DISTANT OBJECT.—A conspicuous object is selected which must be at a considerable distance from the ship and upon which there should be some clearly defined point for taking bearings. The direction of this object by compass is observed on successive headings. Its true or magnetic bearing is then found and compared with the compass bearings, whence the deviation is obtained.

The true or magnetic bearing may be taken from the chart. The magnetic bearing may also be found by setting up a compass ashore, free from foreign magnetic disturbance, in range with the object and the ship, and observing the bearing of the object; or the magnetic bearing may be assumed to be the mean of the compass bearings.

In choosing an object for use in this method care must be taken that it is at such a distance that its bearing from the ship does not practically differ as the vessel swings in azimuth. If the ship is swung at anchor, the distance should be not less than 6 miles. If swung under way, the object must be so far that the parallax (the tangent of which may be considered equal to half the diameter of swinging divided by the distance) shall not exceed about 30′.

**91.** In all of the methods described it will be found convenient to arrange the results in tabular form. In one column record the ship's head by standard compass, and abreast it in successive columns the observations from which the deviation is determined on that heading, and finally write the deviation itself. When the result of the swing has been worked up another table is constructed showing simply the headings and the corresponding deviations. This is known as the *Deviation Table* of the compass. If compensation is to be attempted, this table is the basis of the operation; if not, the deviation tables of the standard and steering compass should be posted in such place as to be accessible to all persons concerned with the navigation of the ship.

**92.** Let it be assumed that a deviation table has been found and that the values are as follows:

*Deviation table.*

| Ship's head by standard compass. | Deviation. | Ship's head by standard compass. | Deviation. | Ship's head by standard compass. | Deviation. | Ship's head by standard compass. | Deviation. |
|---|---|---|---|---|---|---|---|
| | ° ′ | | ° ′ | | ° ′ | | ° ′ |
| North | − 1 00 | East | −19 55 | South | 0 00 | West | +19 30 |
| N. by E | − 1 50 | E. by S | −22 00 | S. by W | +10 20 | W. by N | +17 00 |
| NNE | − 3 00 | ESE | −23 30 | SSW | +17 00 | WNW | +13 00 |
| NE. by N | − 5 15 | SE. by E | −24 00 | SW. by S | +21 50 | NW. by W | +11 10 |
| NE | − 7 10 | SE | −23 30 | SW | +24 30 | NW | + 7 40 |
| NE. by E | −10 15 | SE. by S | −20 30 | SW. by W | +26 20 | NW. by N | + 5 05 |
| ENE | −13 05 | SSE | −16 00 | WSW | +25 00 | NNW | + 3 00 |
| E. by N | −17 10 | S. by E | − 8 50 | W. by S | +23 30 | N. by W | + 1 00 |

We have from the table the amount of deviation on each compass heading; therefore, knowing the ship's head by compass, it is easy to pick out the corresponding deviation and thus to obtain the magnetic heading. But if we are given the magnetic direction in which it is desired to steer and have to find the corresponding compass course, the problem is not so simple, for we are not given deviations on magnetic heads, and where the errors are large it may not be assumed that they are the same as on the corresponding compass headings. For example, with the deviation table just given, suppose it is required to determine the compass heading corresponding to N. 79° W., magnetic.

The deviation corresponding to N. 79° W., per compass, is + 17° 00′. If we apply this to N. 79° W., magnetic, we have S. 84° W. as the compass course. But, consulting the table, it may be seen that the deviation corresponding to S. 84° W., per compass, is + 21½°, and therefore if we steer that course the magnetic direction will be N. 74½° W., and not N. 79° W., as desired.

A way of arriving at the correct result is to make a series of trials until a course is arrived at which fulfills the conditions. Thus, in the example given:

<table>
<tr><td colspan="2"><em>First trial.</em></td><td colspan="2"><em>Second trial.</em></td></tr>
<tr><td>Mag. course required</td><td>N. 79° W.</td><td>Mag. course required</td><td>N. 79° W.</td></tr>
<tr><td>Try dev. on N. 79° W., p. c</td><td>17° E.</td><td>Try dev. on S. 79° W., p. c</td><td>23½° E.</td></tr>
<tr><td>Trial comp. course</td><td>S. 84° W.</td><td>Trial comp. course</td><td>S. 77½° W.</td></tr>
<tr><td>Dev. on S. 84° W., p. c</td><td>21½° E.</td><td>Dev. on S. 77½° W., p. c</td><td>24° E.</td></tr>
<tr><td>Mag. course made good</td><td>N. 74½° W.</td><td>Mag. course made good</td><td>N. 78½° W.</td></tr>
</table>

Since this assumption carries the course 4½° too far to the right, assume next a deviation on a course 5° farther to the left than the one used here.

This is as close to the required course as the ship can be steered. It may occur that further trials will be necessary in some cases.

**93.** The Napier Diagram.—A much more expeditious method for the solution of this problem is afforded by the *Napier Diagram*, and as that diagram also facilitates a number of other operations connected with compass work it should be clearly understood by the navigator. This device admits of a graphic representation of the table of deviations of the compass by means of a curve; besides furnishing a ready means of converting compass into magnetic courses and the reverse, one of its chief merits is that if the deviation has been determined on a certain number of headings it enables one to obtain the most probable value of the deviation on any other course that the ship may head. The last-named feature renders it useful in making a table of deviations of compasses other than the standard when their errors are found as described in article 85.

**94.** The Napier diagram (fig. 9) represents the margin of a compass card cut at the north point and straightened into a vertical line; for convenience, it is usually divided into two sections, representing, respectively, the eastern and western semicircles. The vertical line is of a convenient length and divided into thirty-two equal parts corresponding to the points of the compass, beginning at the top with North and continuing around to the right; it is also divided into 360 degrees, which are appropriately marked.
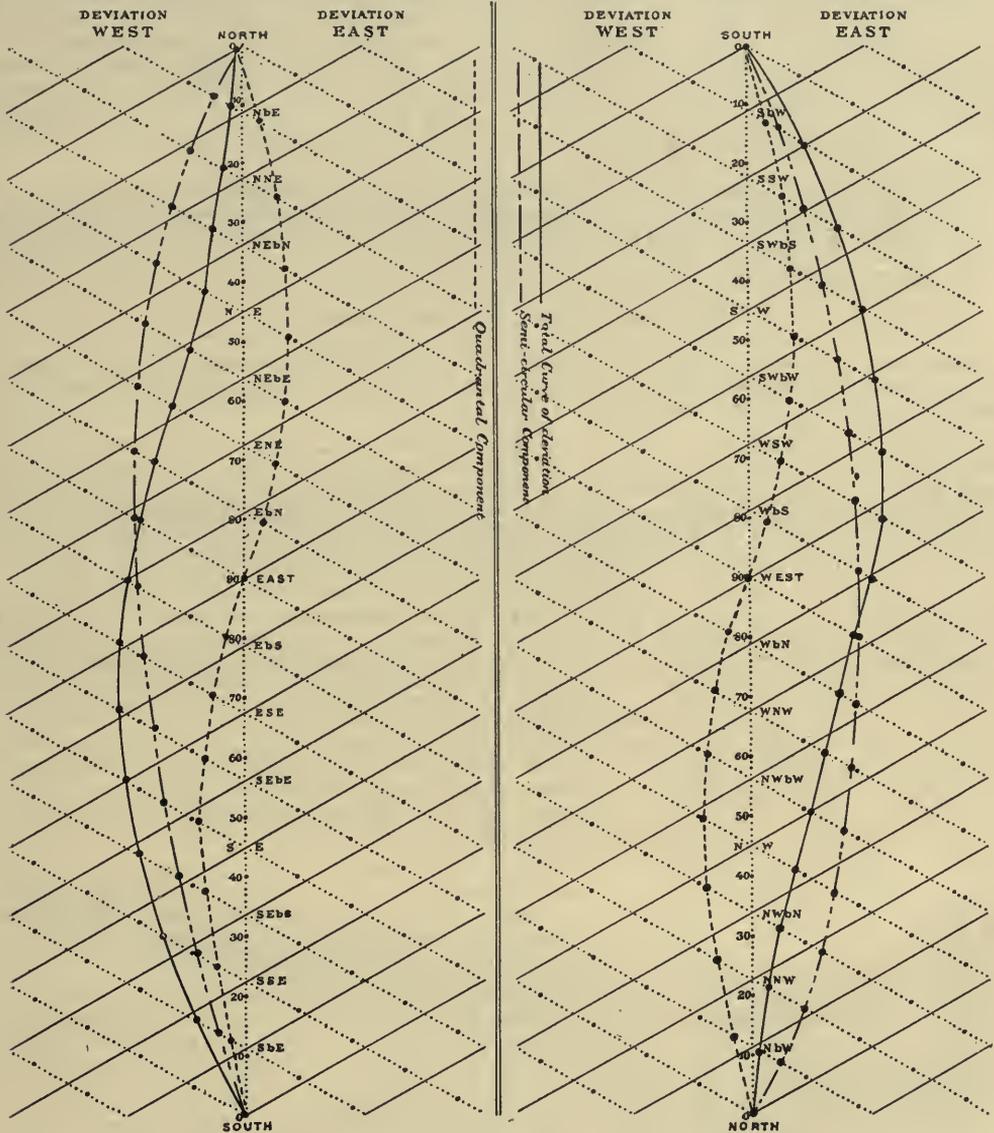


FIG. 9.

The vertical line is intersected at each compass point by two lines inclined to it at an angle of 60°, that line which is inclined upward to the right being drawn plain and the other dotted.

*To plot a curve on the Napier diagram*, if the deviation has been observed with the ship's head on given *compass* courses (as is usually the case with the standard compass), measure off on the vertical scale the number of degrees corresponding to the deviation and lay it down—to the right if easterly and to the left if westerly—on the *dotted* line passing through the point representing the ship's head; or, if the observation was not made on an even point, then lay it down on a line drawn parallel to the dotted ones through that division of the vertical line which represents the compass heading; if the deviation has been observed with the ship on given *magnetic* courses (as when deviations by steering compass are obtained by noting the ship's head during a swing on even points of the standard), proceed in the same way, excepting that the deviation must be laid down on a *plain* line or a line parallel thereto. Mark each point thus obtained with a dot or small circle, and draw a free curve passing, as nearly as possible, through all the points.

6583—06——3

To obtain a complete curve, a sufficient number of observations should be taken while the ship swings through an entire circle. Generally, observations on every alternate point are enough to establish a good curve, but in cases where the maximum deviation reaches 40° it is preferable to observe on every point.

The curve shown in the full line on figure 9 corresponds to the table of deviations given in article 92.

*From a given compass course to find the corresponding magnetic course*, through the point of the vertical line representing the given compass course, draw a line parallel to the *dotted* lines until the curve is intersected, and from the point of intersection draw another line parallel to the plain lines; the point on the scale where this last line cuts the vertical line is the magnetic course sought. The correctness of this solution will be apparent when we consider that the 60° triangles are equilateral, and therefore the distance measured along the vertical side will equal the distance measured along the inclined sides— that is, the deviation; and the direction will be correct, for the construction is such that magnetic directions will be to the right of compass directions when the deviation is easterly and to the left if westerly.

*From a given magnetic course to find the corresponding compass course*, the process is the same, excepting that the first line drawn should follow, or be parallel to, the *plain* lines, and the second, or return line, should be parallel to the dotted; and a proof similar to that previously employed will show the correctness of the result. As an example, the problem given in article 92 may be solved by the diagram, and the result will be found to accord with the solution previously given.

## THE THEORY OF DEVIATION.[a]

**95.** FEATURES OF THE EARTH'S MAGNETISM.—It has already been stated that the earth is an immense natural magnet, with a pole in each hemisphere which is not coincident with the geographical pole; it has also a magnetic equator which lies close to, but not coincident with, the geographical equator.

A magnetic needle freely suspended at a point on the earth's surface, and undisturbed by any other than the earth's magnetic influence, will lie in the plane of the magnetic meridian and at an angle with the horizon depending upon the geographical position.

The magnetic elements of the earth which must be considered are shown in figure 10. The earth's *total force* is represented in direction and intensity by the line AB. Since compass needles are mechanically arranged to move only in a horizontal plane, it becomes necessary, when investigating the effect of the earth's magnetism upon them, to resolve the total force into two components which in the figure are represented by AC and AD. These are known, respectively, as the *horizontal* and *vertical components* of the earth's total force, and are usually designated as H and Z. The angle CAB, which the line of direction makes with the plane of the horizon, is called the *magnetic inclination* or *dip*, and denoted by θ.

It is clear that the horizontal component will reduce to zero at the magnetic poles, where the needle points directly downward, and that it will reach a maximum at the magnetic equator, where the free needle hangs in a horizontal direction. The reverse is true of the vertical component and of the angle of dip.

Values representing these different terms may be found from special charts.

**96.** INDUCTION; HARD AND SOFT IRON.—When a piece of unmagnetized iron or steel is brought within the influence of a magnet, certain magnetic properties are immediately imparted to the former, which itself becomes magnetic and continues to remain so as long as it is within the sphere of influence of the permanent magnet; the magnetism that it acquires under these circumstances is said to be *induced*, and the properties of *induction* are such that that end or region which is nearest the pole of the influencing magnet will take up a polarity opposite thereto. If the magnet is withdrawn, the induced magnetism is soon dissipated. If the magnet is brought into proximity again, but with its opposite pole nearer, magnetism will again be induced, but this time its polarity will be reversed. A further property is that if a piece of iron or steel, while temporarily possessed of magnetic qualities through induction, be subjected to blows, twisting, or mechanical violence of any sort, the magnetism is thus made to acquire a permanent nature.

The softer the metal, from a physical point of view, the more quickly and thoroughly will induced magnetism be dissipated when the source of influence is withdrawn; hard metal, on the contrary, is slow to lose the effect of magnetism imparted to it in any way. Hence, in regarding the different features which affect deviation, it is usual to denominate as hard iron that which possesses retained magnetism of a stable nature, and as soft iron that which rapidly acquires and parts with its magnetic qualities under the varying influences to which it is subjected.

**97.** MAGNETIC PROPERTIES ACQUIRED BY AN IRON OR STEEL VESSEL IN BUILDING.—The inductive action of the earth's magnetism affects all iron or steel within its influence, and the amount and permanency of the magnetism so induced depends upon the position of the metal with reference to the earth's total force, upon its character, and upon the degree of hammering, bending, and twisting that it undergoes.



FIG. 10.

*Labels in figure:* Horizontal Force = H; Dip = θ; Needle; Earth's Total Force; Vertical Force = Z

---

[a] As it is probable that the student will not have practical need of a knowledge of the theory of deviation and the compensation of the compass until after he has mastered all other subjects pertaining to Navigation and Nautical Astronomy, it may be considered preferable to omit the remainder of this chapter at first and return to it later.
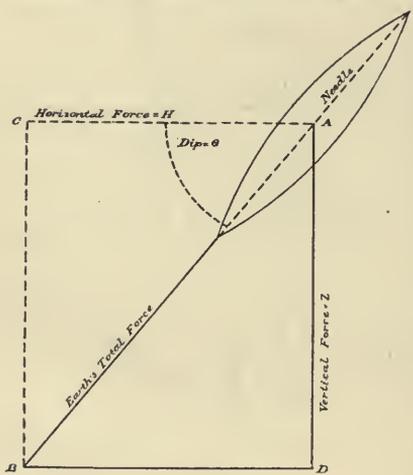
An iron bar held in the line of the earth's total force instantly becomes magnetic; if held at an angle thereto it would acquire magnetic properties dependent for their amount upon its inclination to the line of total force; when held at right angles to the line there would be no effect, as each extremity would be equally near the poles of the earth and all influence would be neutralized. If, while such a bar is in a magnetic state through inductive action, it should be hammered or twisted, a certain magnetism of a permanent character is impressed upon it, which is never entirely lost unless the bar is subjected to causes equal and opposite to those that produced the first effect.

A sheet of iron is affected by induction in a similar way, the magnetism induced by the earth diffusing itself over the entire plate and separating itself into regions of opposite polarity divided by a neutral area at right angles to the earth's line of total force. If the plate is hammered or bent, this magnetism takes up a permanent character.

If the magnetic mass has a third dimension, and assumes the form of a ship, a similar condition prevails. The whole takes up a magnetic character; there is a magnetic axis in the direction of the line of total force, with poles at its extremities and a zone of no magnetism perpendicular to it. The distribution of magnetism will depend upon the horizontal and vertical components of the earth's force in the locality and upon the direction of the keel in building; its permanency will depend upon the amount of mechanical violence to which the metal has been subjected by the riveting and other incidents of construction, and upon the nature of the metal employed.

**98.** CAUSES THAT PRODUCE DEVIATION.—There are three influences that operate to produce deviation; namely, (a) *subpermanent magnetism;* (b) *transient magnetism induced in vertical soft iron,* and (c) *transient magnetism induced in horizontal soft iron.* Their effect will be explained.

*Subpermanent magnetism* is the name given to that magnetic force which originates in the ship while building, through the process explained in the preceding article; after the vessel is launched and has an opportunity to swing in azimuth, the magnetism thus induced will suffer material diminution until, after the lapse of a certain time, it will settle down to a condition that continues practically unchanged; the magnetism that remains is denominated subpermanent. The vessel will then approximate to a permanent magnet, in which the north polarity will lie in that region which was north in building, and the south polarity (that which exerts an attracting influence on the north pole of the compass needle), in the region which was south in building.

*Transient magnetism induced in vertical soft iron* is that developed in the soft iron of a vessel through the inductive action of the vertical component only of the earth's total force, and is transient in nature. Its value or force in any given mass varies with and depends upon the value of the vertical component at the place, and is proportional to the sine of the dip, being a maximum at the magnetic pole and zero at the magnetic equator.

*Transient magnetism induced in horizontal soft iron* is that developed in the soft iron of a vessel through the inductive action of the horizontal component only of the earth's total force, and is transient in nature. Its value or force in any given mass varies with and depends upon the value of the horizontal component at the place, and is proportional to the cosine of the dip, being a maximum at the magnetic equator and reducing to zero at the magnetic pole.

The needle of a compass in any position on board ship will therefore be acted upon by the earth's total force, together with the three forces just described. The poles of these forces do not usually lie in the horizontal plane of the compass needle, but as this needle is constrained to act in a horizontal plane, its movements will be affected solely by the horizontal components of these forces, and its direction will be determined by the resultant of those components.

The earth's force operates to retain the compass needle in the plane of the magnetic meridian, but the resultant of the three remaining forces, when without this plane, deflects the needle, and the amount of such deflection constitutes the deviation.

**99.** CLASSES OF DEVIATION.—Investigation has developed the fact that the deviation produced as described is made up of three parts, which are known respectively as *semicircular, quadrantal,* and *constant* deviation, the latter being the least important. A clear understanding of the nature of each of these classes is essential for a comprehension of the methods of compensation.

**100.** *Semicircular Deviation* is that due to the combined influence, exerted in a horizontal plane, of the subpermanent magnetism of a ship and of the magnetism induced in soft iron by the vertical component of the earth's force. If we regard the effect of these two forces as concentrated in a single resultant pole exerting an attracting influence upon the north end of the compass needle, it may be seen that there will be some heading of the ship whereon that pole will lie due north of the needle and therefore produce no deviation; now consider that, from this position, the ship's head swings in azimuth to the right; throughout all of the semicircle first described an easterly deviation will be produced, and, after completing 180°, the pole will be in a position diametrically opposite to that from which it started, and will again exert no influence that tends to produce deviation. Continuing the swing, throughout the next semicircle the direction of the deviation produced will be always to the westward, until the circle is completed and the ship returns to her original neutral position. From the fact that this disturbing cause acts in the two semicircles with equal and opposite effect it is given the name of *semicircular* deviation.

In figure 9, a curve is depicted which shows the deviations of a semicircular nature separated from those due to other disturbing causes, and from this the reason for the name will be apparent.

**101.** Returning to the two distinct sources from which the semicircular deviation arises, it may be seen that the force due to subpermanent magnetism remains constant regardless of the geographical position of the vessel; but since the horizontal force of the earth, which tends to hold the needle in the magnetic meridian, varies with the magnetic latitude, the deviation due to subpermanent magnetism varies inversely as the horizontal force, or as $\frac{1}{H}$; this may be readily understood if it is considered that the stronger the tendency to cling to the direction of the magnetic meridian, the less will be the deflection due to a given disturbing force. On the other hand, that part of the semicircular force due to magnetism induced in vertical soft iron varies as the earth's vertical force, which is proportional to the

sine of the dip; its effect in producing deviation, as in the preceding case, varies inversely as the earth's horizontal force—that is, inversely as the cosine of the dip; hence the ratio representing the change of deviation arising from this cause on change of latitude is $\dfrac{\sin \theta}{\cos \theta}$, or tan $\theta$.

If, then, we consider the change in the semicircular deviation due to a change of magnetic latitude, it will be necessary to separate the two factors of the deviation and to remember that the portion produced by subpermanent magnetism varies as $\dfrac{1}{H}$, and that due to vertical induction as tan $\theta$. But for any consideration of the effect of this class of deviation in one latitude only, the two parts may be joined together and regarded as having a single resultant.

**102.** If we now resume our former assumption, that all the forces tending to produce semicircular deviation are concentrated in a single pole exerting an attracting influence upon the north pole of the compass, we may consider a line to be drawn joining that theoretical pole with the center of the compass, then the angle made by this line with the keel line of the vessel, measured from right ahead, around to the right is called the *starboard angle*. From this it follows that the disturbing force producing semicircular deviation may be considered to have the same effect as a single magnet whose center is in the vertical axis of the compass, and whose *south* pole (attracting to the north pole of the compass) is in the direction given by the starboard angle; if, therefore, a magnet be placed with its center in the vertical axis of the compass, its *north* (or repelling) pole in the direction of the starboard angle, and its distance so regulated that it exerts upon the compass a force equal to that of the ship's combined subpermanent magnetism and vertical induced magnetism, the disturbing effect of these two forces will be counterbalanced, and, so far as they are concerned, the compass deviations will be corrected, provided that the ship does not change her magnetic latitude.

**103.** It is evident that the force of the single magnet may be resolved into two components—one fore-and-aft, and one athwartship; in this case, instead of being represented by a single magnet with its south pole in the starboard angle, the semicircular forces will be represented by two magnets, one fore-and-aft and the other athwartship, and compensation may be made by two separate magnets lying respectively in the directions stated, but with their north or repelling poles in the position occupied by the south or attracting poles of the ship's force.

Figure 11 represents the conditions that have been described. If O be the center of the compass, XX′ and YY′, respectively, the fore-and-aft and athwartship lines of the ship, and OS the direction in which the attracting pole of the disturbing force is exerted, then XOS is the starboard angle, usually designated $\alpha$. Now, if OP be laid off on the line OS, representing the amount of the disturbing force according to some convenient scale, then O$b$ and O$c$, respectively, represent, on the same scale, the resolved directions of that force in the keel line and in the transverse line of the ship. Each of these resolved forces will exert a maximum effect when acting at right angles to the needle, the athwartship one when the ship heads north or south by compass, and the longitudinal one when the heading is east or west. On any



FIG. 11.

other heading than those named the deviation produced by each force will be a fraction of its maximum whose magnitude will depend upon the azimuth of the ship's head. The maximum deviation produced, therefore, forms in each case a basis for reckoning all of the various effects of the disturbing force, and is called a *coefficient*.

The coefficient of semicircular deviation produced by the force in the fore-and-aft line is called B, and is reckoned as positive when it attracts a north pole toward the bow, negative when toward the stern; that produced by the athwartship force is C, and is reckoned as positive to starboard and negative to port. These coefficients are expressed in degrees.[a]

Referring again to figure 11, it will be seen that:

$$\tan \alpha = \frac{Oc}{Ob};$$

or (what may be shown to be the same thing):

$$\tan \alpha = \frac{\sin C}{\sin B};$$

and when the maximum deviations are small, this becomes:

$$\tan \alpha = \frac{C}{B}.$$

Since the starboard angle is always measured to the right, it will be seen that, for positive values of B and C, $\alpha$ will be between 0° and 90°; for a negative B and a positive C, between 90° and 180°; for

---

[a] It should be remarked that in a mathematical analysis of the deviations, it would be necessary to distinguish between the *approximate coefficients*, B and C, here described, as also A, D, and E, to be mentioned later, and the *exact coefficients* denoted by the corresponding capital letters of the German alphabet. In the practical discussion of the subject here given, the question of the difference need not be entered into.
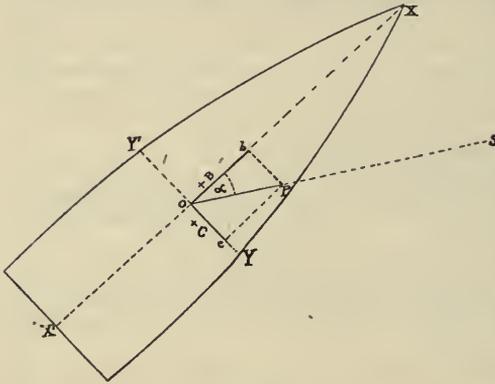
negative values of both B and C, between 180° and 270°; and for a positive B and negative C, between 270° and 360°.

**104.** The coefficient B is approximately equal to the deviation on East; or to the deviation on West with reversed sign; or to the mean of these two. Thus in the ship having the table of deviations previously given (art. 92), B is equal to $-19° 55'$, or to $-19° 30'$, or to $\frac{1}{2}(-19° 55' - 19° 30') = -19° 43'$.

The coefficient C is approximately equal to the deviation on North; or to the deviation on South with reversed sign; or to the mean of these two. In the example C is equal to $-1° 00'$ or $0° 00'$, or $\frac{1}{2}(-1° 00' \pm 0° 00') = -0° 30'$.

**105.** The value of the subpermanent magnetism remaining practically constant under all conditions, it will not alter when the ship changes her latitude; but that due to induction in vertical soft iron undergoes a change when, by change of geographical position, the vertical component of the earth's force assumes a different value, and in such case the correction by means of one or a pair of permanent magnets will not remain effective. If, however, by series of observations in two magnetic latitudes, the values of the coefficients can be determined under the differing circumstances, it is possible, by solving equations, to determine what effect each force has in producing the semicircular deviation; having done which, the subpermanent magnetism can be corrected by permanent magnets after the method previously described, and the vertical induction in soft iron can be corrected by a piece of vertical soft iron placed in such a position near the compass as to produce an equal but opposite force to the ship's vertical soft iron. This last corrector is called a *Flinders bar*.

Having thus opposed to each of the component forces a corrector of magnetic character identical with its own, a change of latitude will make no difference in the effectiveness of the compensation, for in every case the modified conditions will produce identical results in the disturbing and in the correcting force.

**106.** *Quadrantal Deviation* is that which arises from horizontal induction in the soft iron of the vessel through the action of the horizontal component of the earth's total force. Let us consider, in figure 12, the effect of any piece of soft iron which is symmetrical with respect to the compass—that is, which lies wholly within a plane passing through the center of the needle in either a fore-and-aft or an athwart-ship direction. It may be seen (*a*) that such iron produces no deviation on the cardinal points (for on north and south headings the fore-and-aft iron, though strongly magnetized, has no tendency to draw the needle from a north-and-south line, while the athwartship iron, being at right angles to the meridian, receives no magnetic induction, and therefore exerts no force; and on east and west headings similar conditions prevail, the athwartship and the fore-and-aft iron having simply exchanged positions); and (*b*) the direction of the deviation produced is opposite in successive quadrants. The action of unsymmetrical soft iron is not quite so readily apparent, but investigation shows that part of its effect is to produce a deviation which becomes zero at the inter-cardinal points and is of opposite name in successive quadrants. From the fact that deviations of this class change sign every 90° throughout the circle, they gain the name of *quadrantal deviations*. One of the curves laid down in the Napier diagram (fig. 11) is that of quadrantal deviations, whence the nature of this disturbance of the needle may be observed.

**107.** All deviations produced by soft iron may be considered as fractions of the maximum deviation due to that disturbing influence; and consequently the maximum is regarded as a coefficient, as in the case of semicircular deviations. The coefficient due to symmetrical soft iron is designated as D, and is considered positive when it produces easterly deviations in the



FIG. 12.

quadrant between North and East; the coefficient of deviations arising from unsymmetrical soft iron is called E, and is reckoned as positive when it produces easterly deviations in the quadrant between NW. and NE.; this latter attains importance only when there is some marked inequality in the distribution of metal to starboard and to port, as in the case of a compass placed off the midship line.

**108.** D is approximately equal to the mean of the deviations on NE. and SW.; or to the mean of those on SE. and NW., with sign reversed; or to the mean of those means. In the table of deviations given in article 92, D is equal to $\frac{1}{2}(-7° 10' + 24° 30') = +8° 40'$; or to $\frac{1}{2}(+23° 30' - 7° 40') = +7° 55'$; or to $\frac{1}{2}(+8° 40' + 7° 55') = +8° 23'$. By reason of the nature of the arrangement of iron in a ship, D is almost invariably positive.

E is approximately equal to the mean of the deviations on North and South; or to the mean of those on East and West with sign reversed; or to the mean of those means. In the example, E is equal to $\frac{1}{2}(-1° 00' \pm 0° 00') = -0° 30'$; or to $\frac{1}{2}(+19° 55' - 19° 30') = +0° 13'$; or to $\frac{1}{2}(-0° 30' + 0° 13') = -0° 09'$.

**109.** Quadrantal deviation does not, like semicircular, undergo a change upon change of magnetic latitude; being due to induction in horizontal soft iron, the magnetic force exerted to produce it is proportional to the horizontal component of the earth's magnetism; but the directive force of the needle likewise depends upon that same component; consequently, as the disturbing force exerted upon the needle increases, so does the power that holds it in the magnetic meridian, with the result that on any given heading the deflection due to soft iron is always the same.

**110.** Quadrantal deviation is corrected by placing masses of soft iron (usually two hollow spheres in the athwartship line, at equal distances on each side of the compass), with the center of mass in the horizontal plane of the needle. The distance is made such that the force exerted exactly counteracts that of the ship's iron. As the correcting effect of this iron will, like the directive force and the quadrantal disturbing force, vary directly with the earth's horizontal component, the compensation once properly made will be effective in all latitudes.

In practice, the quadrantal deviation due to unsymmetrical iron is seldom corrected; the correction may be accomplished, however, by placing the soft iron masses on a line which makes an angle to the athwartship line through the center of the card.
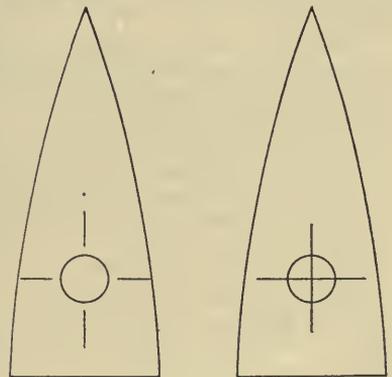
**111.** *Constant Deviation* is due to induction in horizontal soft iron unsymmetrically placed about the compass. It has already been explained that one effect of such iron is to produce a quadrantal deviation, represented by the coefficient E; another effect is the *constant* deviation, so called because it is uniform in amount and direction on every heading of the ship. If plotted on a Napier diagram, it would appear as a straight line parallel with the initial line of the diagram.

**112.** Like other classes of deviation, the effect of the disturbing force is represented by a coefficient; this coefficient is designated as A, and is considered *plus* for easterly and *minus* for westerly errors. It is approximately equal to the mean of the deviations on any number of equidistant headings. In the case previously given, it might be found from the four headings, North, East, South, and West, and would then be equal to $\frac{1}{4}$ ($-1°\ 00'-19°\ 55'\pm0°\ 00'+19°\ 30'$)$=-0°\ 21'$; or from all of the 32 headings, when it would equal $+0°\ 16'$.

For the same reason as in the case of E, the value of A is usually so small that it may be neglected; it only attains a material size when the compass is placed off the midship line, or for some similar cause.

**113.** Like quadrantal deviation, since its force varies with the earth's horizontal force, the constant deviation will remain uniform in amount in all latitudes.

No attempt is made to compensate this class of error.

**114.** COEFFICIENTS.—The chief value of coefficients is in mathematical analyses of the deviations and their causes. It may, however, be a convenience to the practical navigator to find their approximate values by the methods that have been given, in order that he may gain an idea of the various sources of the error, with a view to ameliorating the conditions, when necessary, by moving the binnacle or altering the surrounding iron. The following relation exists between the coefficients and the deviation:

$$d = A + B \sin z' + C \cos z' + D \sin 2z' + E \cos 2z',$$

where $d$ is the deviation, and $z'$ the ship's heading by compass, measured from compass North.

**115.** MEAN DIRECTIVE FORCE.—The effect of the disturbing forces is not confined to causing deviations; it is only those components acting at right angles to the needle which operate to produce deflection; the effect of those acting in the direction of the needle is exerted either in increasing or diminishing the directive force of the compass, according as the resolved component is northerly or southerly.

It occurs, with the usual arrangement of iron in a vessel, that the mean effect of this action throughout a complete swing of the ship upon all headings is to reduce the directive force—that is, while it varies with the heading the average value upon all azimuths is *minus* or southerly. The result of such a condition is unfavorable from the fact that the compass is thus made more "sluggish," is easily disturbed and does not return quickly to rest, and a given deflecting force produces a greater deviation when the directive force is reduced. The usual methods of compensation largely correct this fault, but do not entirely do so; it is therefore the case that the mean combined horizontal force of earth and ship to north is generally less than the horizontal force of the earth alone; but it is only in extreme cases that this deficiency is serious.

**116.** HEELING ERROR.—This is an additional cause of deviation that arises when the vessel heels to one side or the other. Heretofore only those forces have been considered which act when the vessel is on an even keel; but if there is an inclination from the vertical certain new forces arise, and others previously inoperative become effective. These forces are (*a*) the vertical component of the subpermanent magnetism acquired in building; (*b*) the vertical component of the induced magnetism in vertical soft iron, and (*c*) the magnetism induced by the vertical component of the earth's total force in iron which, on an even keel, was horizontal. The first two of these disturbing causes are always present, but, when the ship is upright, have no tendency to produce deviation, simply exerting a downward pull on one of the poles of the needle; the last is a new force that arises when the vessel heels.

The maximum disturbance due to heel occurs when the ship heads North or South. When heading East or West there will be no deviation produced, although the directive force of the needle will be increased or diminished. The error will increase with the amount of inclination from the vertical.

**117.** For the same reason as was explained in connection with semicircular deviations, that part of the heeling error due to subpermanent magnetism will vary, on change of latitude, as $\frac{1}{H}$, while that due to vertical induction will vary as tan $\theta$. In south magnetic latitude the effect of vertical induction will be opposite in direction to what it is in north.

**118.** The heeling error is corrected by a permanent magnet placed in a vertical position directly under the center of the compass. Such a magnet has no effect upon the compass when the ship is upright; but since its force acts in an opposite direction to the force of the ship which causes heeling error, is equal to the latter in amount, and is exerted under the same conditions, it affords an effective compensation. For similar reasons to those affecting the compensation of B and C, the correction by means of a permanent magnet is not general, and must be rectified upon change of latitude.

## PRACTICAL COMPENSATION.

**119.** In the course of explanation of the different classes of deviation occasion has been taken to state generally the various methods of compensating the errors that are produced. The practical methods of applying the correctors will next be given.

**120.** ORDER OF CORRECTION.—The following is the order of steps to be followed in each case. It is assumed that the vessel is on an even keel, that all surrounding masses of iron or steel are in their normal positions, all correctors removed, and that the binnacle is one in which the semicircular deviation is corrected by two sets of permanent magnets at right angles to each other.

1. Place quadrantal correctors by estimate.
2. Correct semicircular deviations.

3. Correct quadrantal deviations.

4. Swing ship for residual deviations.

The heeling corrector may be placed at any time after the semicircular and quadrantal errors are corrected. A Flinders bar can be put in place only after observations in two latitudes.

**121.** The ship is first placed on some magnetic cardinal point. If North or South, the only force (theoretically speaking) which tends to produce deflection of the needle will be the athwartship component of the semicircular force, whose effect is represented by the coefficient C. If East or West, the only deflecting force will be the fore-and-aft component of the semicircular force, whose effect is represented by the coefficient B. This will be apparent from a consideration of the direction of the forces producing deviation, and is also shown by the equation connecting the terms (where A and E are zero):

$$d = \text{B} \sin z' + \text{C} \cos z' + \text{D} \sin 2z'.$$

If the ship is headed North or South, $z'$ being equal to 0° or 180°, the equation becomes $d = \pm \text{C}$. If on East or West, $z'$ being 90° or 270°, we have $d = \pm \text{B}$.

This statement is exact if we regard only the forces that have been considered in the problem, but experience has demonstrated that the various correctors when in place create certain additional forces by their mutual action, and in order to correct the disturbances thus accidentally produced, as well as those due to regular causes, it is necessary that the magnetic conditions during correction shall approximate as closely as possible to those that exist when the compensation is completed; therefore the quadrantal correctors should first be placed on their arms at the positions which it is estimated that they will occupy later when exactly located. An error in the estimate will have but slight effect under ordinary conditions. It should be understood that the placing of these correctors has no corrective effect while the ship is on a cardinal point. Its object is to create at once the magnetic field with which we shall have to deal when compensation is perfected.

This having been done, proceed to correct the semicircular deviation. If the ship heads North or South, the force producing deflection is, as has been stated, the athwartship component of the semicircular force, which is to be corrected by permanent magnets placed athwartships; therefore enter in the binnacle one or more such magnets, and so adjust their height that the heading of the ship by compass shall agree with the magnetic heading. When this is done all the deviation on that azimuth will be corrected.

Similarly, if the ship heads East or West, the force producing deviation is the fore-and-aft component of the semicircular force, and this is to be corrected by entering fore-and-aft permanent magnets in the binnacle and adjusting the height so that the deviation on that heading disappears.

With the deviation on two adjacent cardinal points corrected, the semicircular force has been completely compensated. Next correct the quadrantal deviation. Head the ship NE., SE., SW., or NW. The coefficients B and C having been reduced to zero by compensation, and $2z'$, on the azimuths named, being equal to 90° or 270°, the equation becomes $d = \pm \text{D}$. The soft-iron correctors are moved in or out from the positions in which they were placed by estimate until the deviation on the heading (all of which is due to quadrantal force) disappears. The quadrantal disturbing force is then compensated.

**122.** DETERMINATION OF MAGNETIC HEADINGS.—To determine when the ship is heading on any given magnetic course, and thus to know when the deviation has been corrected and the correctors are in proper position, four methods are available:

(*a*) Swing the ship and obtain by the best available method the deviations on a sufficient number of compass courses to construct a curve on the Napier diagram for one quadrant, and thus find the compass headings corresponding to two adjacent magnetic cardinal points and the intermediate intercardinal point, as North, NE., and East, magnetic.[a] Then put the ship successively on these courses, noting the corresponding headings by some other compass, and when it is desired to head on the various magnetic azimuths during the process of correction the ship may be steadied upon them by the auxiliary compass. Variations of this method will suggest themselves and circumstances may render their adoption convenient. The compass courses corresponding to the magnetic directions may be obtained from observations made with the auxiliary compass itself, or while making observations with another compass the headings by the auxiliary may be noted and a curve for the latter constructed, as explained in article 94, and the required headings thus deduced.

(*b*) By the methods to be explained hereafter (Chap. XIV), ascertain in advance the true bearing of the sun at frequent intervals during the period which is to be devoted to the compensation of the compasses; apply to these the variation and obtain the magnetic bearings; record the times and bearings in a convenient tabular form; set the watch accurately for the local apparent time; then when it is required to steer any given magnetic course, set that point of the pelorus for the ship's head and set the sight vanes for the magnetic bearing of the sun corresponding to the time by watch. Maneuver the ship with the helm until the sun comes on the sight vanes, when the azimuth of the ship's head will be that which is required. The sight vanes must be altered at intervals to accord with the table of times and bearings.

(*c*) Construct a table showing times and corresponding magnetic bearings of the sun, and also set the watch, as explained for the previous method. Then place the sight vanes of the azimuth circle of the compass at the proper angular distance to the right or left of the required azimuth of the ship's head; leave them so set and maneuver the ship with the helm until the image of the sun comes on with the vanes. The course will then be the required one. As an example, suppose that the table shows that the magnetic azimuth of the sun at the time given by the watch is N. 87° E., and let it be required to head magnetic North; when placed upon this heading, therefore, the sun must bear 87° to the right, or east, of the direction of the ship's head; when steady on any course, turn the sight vane to the required bearing relative to the keel. If on N. 11° W., for example, turn the circle to N. 76° E.; leave the vane

[a] This is all that is required for the purposes of compensation, but if there is opportunity it is always well to make a complete swing and obtain a full table of deviations, which may give interesting information of the existing magnetic conditions.

undisturbed and alter course until the sun comes on. The magnetic heading is then North, and adjustment may be made accordingly.

(d) When ranges are available, they may be utilized for determining magnetic headings.

**123.** SUMMARY OF ORDINARY CORRECTIONS.—To summarize, the following is the process of correcting a compass for a single latitude, where magnets at right angles are employed for compensating the semicircular deviation and where the disturbances due to unsymmetrical soft iron are small enough to be neglected:

First. All correctors being clear of the compass, place the quadrantal correctors in the position which it is estimated that they will occupy when adjustment is complete. · The navigator's experience will serve in making the estimate, or if there seems no other means of arriving at the probable position they may be placed at the middle points of their supports.

Second. Steady the ship on magnetic North, East, South, or West, and hold on that heading by such method as seems best. By means of permanent magnets alter the indications of the compass until the heading coincides with the magnetic course. If heading North, magnets must be entered N. ends to starboard to correct easterly deviation and to port to correct westerly, and the reverse if heading South. If heading East, enter N. ends forward for easterly and aft for westerly deviations, and the reverse if heading West. (Binnacles differ so widely in the methods of carrying magnets that details on this point are omitted. It may be said, however, that the magnetic intensity of the correctors may be varied by altering either their number or their distance from the compass; generally speaking, several magnets at a distance are to be preferred to a small number close to the compass.)

Third. Steady the ship on an adjacent magnetic cardinal point and correct the compass heading by permanent magnets to accord therewith in the same manner as described for the first heading.

Fourth. Steady the ship on an intercardinal point (magnetic) and move the quadrantal correctors away from or toward the compass, keeping them at equal distances therefrom, until the compass and magnetic headings coincide.

**124.** The compensation being complete, the navigator should proceed immediately to swing ship and make a table of the residual deviations. Though the remaining errors will be small, it is seldom that they will be reduced to zero, and it must never be assumed that the compass may be relied upon without taking the deviation into account. Observations on eight equidistant points will ordinarily suffice for this purpose.

**125.** To CORRECT SEMICIRCULAR DEVIATION WITH A SINGLE MAGNET.—In certain binnacles provision is made for correcting the semicircular deviation by a single magnet (or series of magnets) in the starboard angle, the magnet tray having motion in azimuth as well as vertically. In this case the process of correcting semicircular deviation is somewhat different from that described for correction by rectangular magnets. Either of the two following methods may be employed:

(a) By computation determine the starboard angle. An approximate method for doing this is given in article 103, and a more exact one may be found in works treating this subject mathematically. Head the ship on a cardinal point (magnetic); enter the magnets in the tray and revolve it until their N. ends lie at an angular distance from ahead (measured to the right) equal to the starboard angle; raise or lower the tray until the deviation disappears.

(b) Head the ship on a cardinal point (magnetic), enter the magnets, and turn the tray to an east-and-west position, the N. ends in such direction as will tend to reduce the deviation; raise or lower the tray until the deviation disappears. Alter course 90° and head on an adjacent magnetic cardinal point; observe the amount of deviation that the compass shows; correct half of this by altering the starboard angle and the other half by raising or lowering the tray. Return to first course, note deviation, and correct one-half in each way, as before. Continue the operation, making a series of trials until the deviations disappear on both headings, when the compensation will be correct. This operation may be considerably hastened by finding the first position of the magnets from a rough calculation of the starboard angle (art. 103).

**126.** CORRECTING THE HEELING ERROR.—The heeling error may be corrected by a method involving computation, together with certain observations on shore. A more practical method, however, is usually followed, though its results may be less precise. The heeling corrector is placed in its vertical tube, N. end uppermost in north latitudes, as this is almost invariably the required direction; the ship being on a course near North or South and rolling, observe the vibrations of the card, which, if the error is material, will be in excess of those due to the ship's real motion in azimuth; slowly raise or lower the corrector until the abnormal vibrations disappear, when the correction will be made for that latitude; but it must be readjusted upon any considerable change of geographical position.

In making this observation care must be taken to distinguish the vessel's "yawing" in a seaway, from the apparent motion due to heeling error; for this reason it may be well to have an assistant to watch the ship's head and keep the adjuster informed of the real change in azimuth, by which means the latter may better judge the effect of the heeling error.

In the case of a sailing vessel, or one which for any reason maintains a nearly steady heel for a continuous period, the amount of the heeling error may be exactly ascertained by observing the azimuth of the sun, and corrected with greater accuracy than is possible with a vessel which is constantly rolling.

**127.** FLINDERS BAR.—The simplest method that presents itself for the placing of the Flinders bar is one which is available only for a vessel crossing the magnetic equator. Magnetic charts of the world show the geographical positions at which the dip becomes zero—that is, where a freely suspended needle is exactly horizontal and where there exists no vertical component of the earth's total magnetic force. In such localities it is evident that the factor of the semicircular deviation due to vertical induction disappears and that the whole of the existing semicircular deviation arises from subpermanent magnetism. If, then, when on the magnetic equator the compass be carefully compensated, the effect of the subpermanent magnetism will be exactly opposed by that of the semicircular correcting magnets. Later, as the ship departs from the magnetic equator, the semicircular deviation will gradually acquire a material value, which will be known to be due entirely to vertical induction, and if the Flinders bar be so placed as to correct it, the compensation of the compass will be general for all latitudes.

In following this method it may usually be assumed that the soft iron of the vessel is symmetrical with respect to the fore-and-aft line and that the Flinders bar may be placed directly forward of the compass or directly abaft it, disregarding the effect of components to starboard or port. It is therefore merely necessary to observe whether a vertical soft iron rod must be placed forward or abaft the compass to reduce the deviation, and, having ascertained this fact, to find by experiment the exact distance at which it completely corrects the deviation.

The Flinders bar frequently consists of a bundle of soft iron rods contained in a case, which is secured in a vertical position near the compass, its upper end level with the plane of the needles; in this method, the distance remaining fixed, the intensity of the force that it exerts is varied by increasing or decreasing the number of rods; this arrangement is more convenient and satisfactory than the employment of a single rod at a variable distance.

**128.** When it is not possible to correct the compass at the magnetic equator there is no ready practical method by which the Flinders bar may be placed; the operation will then depend entirely upon computation, and as a mathematical analysis of deviations is beyond the scope laid out for this work the details of procedure will not be gone into; the general principles involved are indicated, and students seeking more must consult the various works that treat the subject fully.

It has been explained that each coefficient of semicircular deviation (B and C) is made up of a sub-permanent factor varying as $\frac{1}{H}$ and of a vertical induction factor varying as $\tan \theta$. If we indicate by the subscripts $_s$ and $_v$, respectively, the parts due to each force, we may write the equations of the coefficients:

$$B = B_s \times \frac{1}{H} + B_v \times \tan \theta; \text{ and}$$

$$C = C_s \times \frac{1}{H} + C_v \times \tan \theta.$$

Now if we distinguish by the subscripts $_1$ and $_2$ the values in the first and in the second position of observation, respectively, of those quantities that vary with the magnetic latitude, we have:

$$B_1 = B_s \times \frac{1}{H_1} + B_v \times \tan \theta_1,$$

$$B_2 = B_s \times \frac{1}{H_2} + B_v \times \tan \theta_2; \text{ and}$$

$$C_1 = C_s \times \frac{1}{H_1} + C_v \times \tan \theta_1,$$

$$C_2 = C_s \times \frac{1}{H_2} + C_v \times \tan \theta_2.$$

The values of the coefficients in both latitudes are found from the observations made for deviations; the values of the horizontal force and of the dip at each place are known from magnetic charts; hence we may solve the first pair of equations for $B_s$ and $B_v$, and the second pair for $C_s$ and $C_v$; and having found the values of these various coefficients, we may correct the effects of $B_s$ and $C_s$ by permanent magnets in the usual way and correct the remainder—that due to $B_v$ and $C_v$—by the Flinders bar.

Strictly, the Flinders bar should be so placed that its repelling pole is at an angular distance from ahead equal to the "starboard angle" of the attracting pole of the vertical induced force, this angle depending upon the coefficients $B_v$ and $C_v$; but since, as before stated, horizontal soft iron may usually be regarded as symmetrical, $C_v$ is assumed as zero and the bar placed in the midship line.

**129.** To Correct Adjustment on Change of Latitude.—The compensation of quadrantal deviation, once properly made, remains effective in all latitudes; but unless a Flinders bar is used a correction of the semicircular deviation made in one latitude will not remain accurate when the vessel has materially changed her position on the earth's surface. With this in mind the navigator must make frequent observations of the compass error during a passage and must expect that the table of residual deviations obtained in the magnetic latitude of compensation will undergo considerable change as that latitude is departed from. The new deviations may become so large that it will be found convenient to readjust the semicircular correcting magnets. This process is very simple.

*When correctors at right angles are used,* provide for steadying the ship, by an auxiliary compass or by the pelorus, upon two adjacent magnetic cardinal points (art. 122). Put the ship on heading North or South (magnetic), and raise or lower the athwartship magnets or alter their number until the deviation disappears; then steady on East or West (magnetic) and similarly adjust the fore-and-aft magnets. Swing ship for a new table of residual deviations.

*When correctors in the starboard angle are used,* arrange as before for heading on two adjacent cardinal magnetic courses. Steady on one of these, observe amount of compass error, correct half by changing the starboard angle and half by raising or lowering magnets; steady on the adjacent cardinal point and repeat the operation. Continue until adjustment is made on both headings, then swing for residual deviations.

# CHAPTER IV.

## PILOTING.

**130.** DEFINITION.—*Piloting*, in the sense given the word by modern and popular usage, is the art of conducting a vessel in channels and harbors and along coasts, where landmarks and aids to navigation are available for fixing the position, and where the depth of water and dangers to navigation are such as to require a constant watch to be kept upon the vessel's course and frequent changes to be made therein.

**131.** REQUISITES.—As requisites to successful piloting, the navigator should be provided with the best available chart of the locality to be traversed, together with the sailing directions and descriptions of aids to navigation; and all of these should be corrected for the latest information, published in notices to mariners or otherwise, that bear upon the locality. The vessel should be equipped with the usual instruments employed in navigation. The deep-sea sounding-machine, if provided, should be ready for use when there is a chance that it may be needed. The lead lines should be correctly marked, and as shoal water is entered one or two men should be stationed to sound. The index errors of the sextants should be known, and, above all, there should be at hand a table showing correctly the deviation of the compass on each heading.

**132.** LAYING THE COURSE.—Mark a point upon the chart at the ship's position; then mark another point for which it is desired to steer; join the two by a line drawn with the parallel ruler, and, maintaining the direction of the line, move the ruler until its edge passes through the center of the compass rose and note the direction. If the compass rose indicates *true* directions, this will be the true course, and must be corrected for variation and deviation (by applying each in the *opposite* direction to its name) to obtain the compass course; if it is a *magnetic* rose, the course need be corrected for deviation only.

Before putting the ship on any course a careful look should be taken along the line over which it leads to be assured that it clears all dangers.

**133.** METHODS OF FIXING POSITION.—A navigator in sight of objects whose positions are shown upon the chart may locate his vessel by either of the following methods: (*a*) cross bearings of two known objects; (*b*) the bearing and distance of a known object; (*c*) the bearing of a known object and the angle between two known objects; (*d*) two bearings of a known object separated by an interval of time, with the run during that interval; (*e*) sextant angles between three known objects. Besides the foregoing there are two methods by which, without obtaining the precise position, the navigator may assure himself that he is clear of any particular danger. These are: (*f*) the danger angle; (*g*) the danger bearing.

The choice of the method will be governed by circumstances, depending upon which is best adapted to prevailing conditions.

**134.** CROSS BEARINGS OF TWO KNOWN OBJECTS.—Choose two objects whose position on the chart can be unmistakably identified and whose respective bearings from the ship differ, as nearly as possible, by 90°; observe the bearing of each, either by compass or pelorus, taking one as quickly as possible after the other; see that the ship is on an even keel at the time the observation is made, and, if using the pelorus, be sure also that she heads exactly on the course for which the pelorus is set. Correct the bearings so that they will be either true or magnetic, according as they are to be plotted by the true or magnetic compass rose of the chart—that is, if observed by compass, apply deviation and variation to obtain the true bearing, or deviation only to obtain the magnetic; if observed by pelorus, that instrument should be set for the true or magnetic heading, according as one or the other sort of reading is required, and no further correction will be necessary. Draw on the chart, by means of the parallel rulers, lines which shall pass through the respective objects in the direction that each was observed to bear. As the ship's position on the chart is known to be at some point of each of these lines, it must be at their intersection, the only point that fulfills both conditions.

In figure 13, if A and B are the objects and OA and OB the lines passing through them in the observed directions, the ship's position will be at O, their intersection.

**135.** If it be possible to avoid it, objects should not be selected for a cross bearing which subtend an angle at the ship of less than 30° or more than 150°, as, when the lines of bearing approach parallelism, a small error in an observed bearing gives a large error in the result. For a similar reason objects near the ship should be taken in preference to those at a distance.



FIG. 13.

**136.** When a third object is available a bearing of that may be taken and plotted. If this line intersects at the same point as the other two (as the bearing OC of the object C in the figure), the navigator may have a reasonable assurance that his "fix" is correct; if it does not, it indicates an error somewhere, and it may have arisen from inaccurate observation, incorrect determination or application of the deviation, or a fault in the chart.
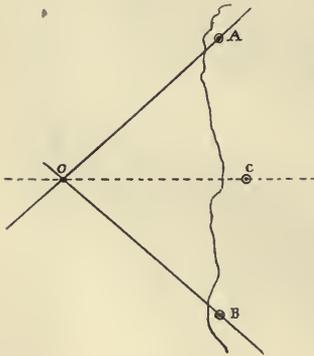
**137.** What may be considered as a form of this method can be used when only one known object is in sight by taking, at the same instant as the bearing, an altitude of the sun or other heavenly body and noting the time; work out the sight and obtain the Sumner line (as explained in Chapter XV), and the intersection of this with the direction-line from the object will give the observer's position in the same way as from two terrestrial bearings.

**138.** BEARING AND DISTANCE OF A KNOWN OBJECT.—When only one object is available, the ship's position may be found by observing its bearing and distance. Follow the preceding method in the matters of taking, correcting, and plotting the bearing; then, on this line, lay off the distance from the object, which will give the point occupied by the observer. In figure 14, if A represents the object and AO the bearing and distance, the position sought will be at O.
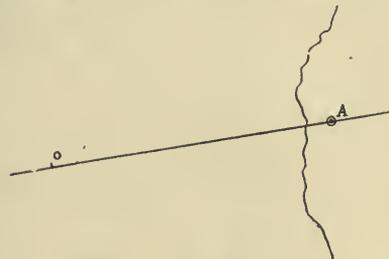
**139.** It is not ordinarily easy to find directly the distance of an object at sea. The most accurate method is when its height is known and it subtends a fair-sized angle from the ship, in which case the angle may be measured by a sextant,[a] and the distance computed or taken from a table. Table 33 of this work gives distances up to 5 miles, corresponding to various heights and angles. Captain Lecky's "Danger Angle and Offshore Distance Tables" carries the computation much further. The use of this method at great distances must not be too closely relied upon, as small errors, such as those due to refraction, may throw out the results to a material extent; but it affords an excellent approximation, and as this method of fixing position is employed only when no other is available the best possible approximation has to suffice.



FIG. 14.
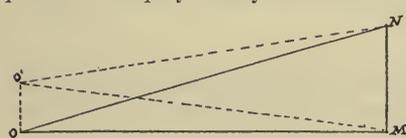
In measuring vertical angles, strictness requires that the observation should be so made that the angle at the foot of the object should equal 90° and that the triangle be a right triangle, as OMN, figure 15, where the line OM is truly horizontal, and not as in the triangle O'MN, where the condition is not fulfilled. This error is inappreciable, however, save at very close distances, when it may be sufficiently corrected by getting down as low as possible on board the vessel, so that the eye is near the water-line. One condition exists, however, where the error is material—that shown in figure 16, where the visible shore-line is at M', a considerable distance from M, the point vertically below the summit. In this case there is nothing to mark M in the observer's eye, and it is essential that all angles be measured from a point close down to the water-line.



FIG. 15.

If a choice of objects can be made, the best results will be obtained by observing that one which subtends the greatest angle, as small errors will then have the least effect.
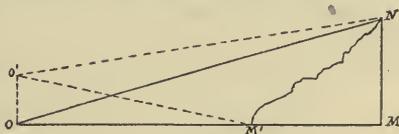


FIG. 16.

There is another method for determining the distance of an object, which is available under certain circumstances. This consists in observing, from a position aloft, the angle between the object and the line of the sea horizon beyond. By reference to Table 34 will be found the distance in yards corresponding to different angles for various heights of the observer from 20 to 120 feet. The method is not accurate beyond moderate distances (the table being limited to 5,000 yards) and is obviously only available for finding the distance of an isolated object, such as an islet, vessel, or target, over which the horizon may be seen. In employing this method the higher the position occupied by the observer the more precise will be the results.

**140.** In observing small angles, such as those that occur in the methods just described, it is sometimes convenient to measure them *on and off* the limb of the sextant. First look at the bottom of the object and reflect the top down into coincidence; then look through the transparent part of the horizon glass at the top and bring the bottom up by its reflected ray. The mean of the two readings will be the true angle, the index correction having been eliminated by the operation.

**141.** When the methods of finding distance by a vertical or a horizon angle are not available, it must be obtained by such means as exist. Estimate the distance by the appearance; take a sounding, and note where the depth falls upon the line of bearing; at night, if atmospheric conditions are normal, consider that the distance of a light when sighted is equal to its maximum range of visibility, remembering that its range is stated for a height of eye of 15 feet; or employ such method as suggests itself under the circumstances, regarding the result, however, as an approximation only.

**142.** THE BEARING OF A KNOWN OBJECT AND THE ANGLE BETWEEN TWO KNOWN OBJECTS.—This method is seldom employed, as the conditions always permit of cross bearings being taken, and the latter is generally considered preferable.

Take a bearing of a known object by compass or pelorus and observe the sextant angle between some two known objects. The line of bearing is plotted as in former methods. In case one of the objects of the observed angle is that whose bearing is taken, the angle is applied, right or left as the case may be, to the bearing, thus giving the direction of the second object, which is plotted from the compass rose and parallel rulers. If the object whose bearing is taken is not one of the objects of the angle, lay off the angle on a three-armed protractor, or piece of tracing paper, and swing it (keeping the legs or lines always over the two objects) until it passes over the line of bearing, which defines the position of the ship; there will, except in special cases, be two points of intersection of the line with the circle thus described, and the navigator must know his position with sufficient closeness to judge which is correct.

**143.** TWO BEARINGS OF A KNOWN OBJECT.—This is a most useful method, which is frequently employed, certain special cases arising thereunder being particularly easy of application. The process

[a] The use of the sextant is explained in Chapter VIII.

is to take a careful bearing and at the same moment read the patent log; then, after running a convenient distance, take a second bearing and again read the log, the difference in readings giving the intervening run; when running at a known speed, the time interval will also afford a means for determining the distance run.

The problem is as follows: In figure 17, given OA, the direction of a known object, A, at the first observation; PA, the direction at the second observation; and OP, the distance traversed between the two; to find AP, the distance at the second observation.

Knowing the angle POA, the angular distance of the object from right ahead at the first bearing; OPA, the angular distance from right astern at the second bearing; and OP, the distance run; we have by Plane Trigonometry:

$$PAO = 180° - (POA + OPA); \text{ and}$$
$$AP = OP \times \frac{\sin POA}{\sin PAO}.$$

If, as is frequently the case, we desire to know the distance of passing abeam, we have:

$$AQ = AP \times \sin OPA.$$
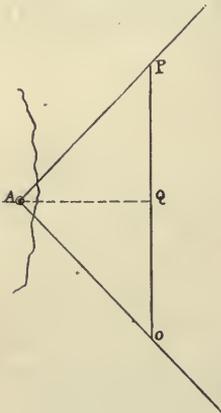
Tables 5A and 5B give solutions for this problem, the former for intervals of bearing of quarter points, the latter for intervals of two degrees. The first column of each of these tables gives the value of AP, the distance of the ship from the observed object at the time of taking the last bearing, for values of OP equal to unity; that is, for a run between bearings of 1 mile. The second column gives AQ, the distance of the object when it bears abeam, likewise for a value of OP of 1 mile. When the run between bearings is other than 1 mile, the number taken from the table must be used as a multiplier of that run to give the required distance.

FIG. 17.

EXAMPLE: A vessel steering north takes a bearing of a light NW. ½ W.; then runs 4.3 miles, when the bearing is found to be WSW. Required the distance of the light at the time of the second bearing.

Difference between course and first bearing, 4½ pts.
Difference between course and second bearing, 10 pts.
Multiplier from first column, Table 5A, 0.88.
4.3 miles × 0.88 = 3.8 miles, distance at second bearing.

EXAMPLE: A vessel on a course S. 52° E. takes the first bearing of an object at S. 26° E., and the second at S. 2° W., running in the interval 0.8 mile. Required the distance at which she will pass abeam.

Difference between course and first bearing, 26°.
Difference between course and second bearing, 54°.
Multiplier from second column, Table 5B, 0.76.
0.8 mile × 0.76 = 0.6 mile, distance of passing abeam.

**144.** As has been said, there are certain special cases of this problem where it is exceptionally easy of application; these arise when the multiplier is equal to unity, and the distance run is therefore equal to the distance from the object. When the angular distance on the bow at the second bearing is twice as great as it was at the first bearing, the distance of the object from the ship *at second bearing* is equal to the run, the multiplier being 1.0. For if, in figure 18, when the ship is in the first position, O, the object A bears $\alpha°$ on the bow, and at the second position, P, $2\alpha°$, we have in the triangle APO, observing that $APO = 180° - 2\alpha$, and $POA = \alpha$:

$$PAO = 180° - (POA + APO),$$
$$= 180° - (\alpha + 180° - 2\alpha),$$
$$= \alpha.$$

Or, since the angles at O and at A are equal to each other, the sides OP and AP are equal, or the distance at second bearing is equal to the run. This is known as *doubling the angle on the bow.*

**145.** A case where this holds good is familiar to every navigator as the *bow and beam bearing*, where the first bearing is taken when the object is broad on the bow (four points or 45° from ahead) and the second when it is abeam (eight points or 90° from ahead); in that case the distance at second bearing and the distance abeam are identical and equal to the run between bearings.

**146.** When the first bearing is 26½° from ahead, and the second 45°, the distance *at which the object will be passed abeam* will equal the run between bearings; this may be proved by computation or by reference to the tables and is a very convenient fact to remember, as it shows the navigator at once, if about to pass a point, how wide a berth he is going to give the offlying dangers.

FIG. 18.

**147.** There is a *graphic method* of solving this problem that is considered by some more convenient than the use of multipliers. Draw upon the chart the lines OA and PA (fig. 19), passing through the object on the two observed bearings; set the dividers to the distance run, OP; lay down the parallel rulers in a direction parallel to the course and move them toward or away from the observed object until some point is found where the distance between the lines of bearing is exactly equal to the distance between the points of the dividers; in the figure this occurs when the rulers lie along the line
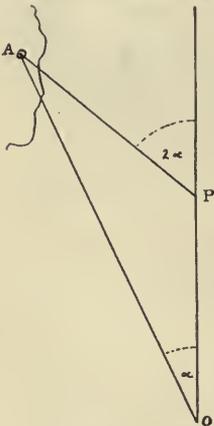
OP, and therefore O represents the position of the ship at the first bearing and P at the second. For any other positions O'P', O''P'', the condition is not fulfilled.

**148.** Another graphic solution is given by the *Distance Finder*, devised by Lieut. J. B. Blish, U. S. Navy. This consists of a semicircle whose circumference is graduated in degrees. Two pieces of thread, made to swing about a pin-head at the center, are laid down to represent the lines of bearing, and ease in measuring distances is afforded by series of cross lines similar to those on a piece of profile paper.

**149.** The method of obtaining position by two bearings of the same object is one of great value, by reason of the fact that it is frequently necessary to locate the ship when there is but one landmark in sight. Careful navigators seldom, if ever, miss the opportunity for a bow and beam bearing in passing a light-house or other well-plotted object; it involves little or no trouble, and always gives a feeling of added security, however little the position may be in doubt. If about to pass an object abreast of which there is a danger—a familiar example of which is when a light-house marks a point off which are rocks or shoals—a good assurance of clearance should be obtained before bringing it abeam, either by doubling the angle on the bow, or by using the 26½°–45° bearing; the latter has the advantage over the former if the object is sighted in time to permit of its use, as it may be assumed that the 45° (bow) bearing will always be observed in any event, and this gives the distance abeam directly, saving the necessity of plotting the position at second bearing (as obtained by doubling the angle) and then carrying it forward.

**150.** It must be remembered that, however convenient, the fix obtained by two bearings of the same object will be in error unless the course and distance are correctly estimated, the course "made



FIG. 19.

good" and the distance "over the ground" being required. Difficulty will occur in estimating the exact course when there is bad steering, a cross current, or when a ship is making leeway; errors in the allowed run will arise when she is being set ahead or back by a current or when the logging is inaccurate. To take a not extreme case, a vessel making 10 knots through the water, running against a 2-knot tide, will overestimate her distance one-fifth of its true amount in taking a bow and beam bearing if no allowance is made for the tide, or she will underestimate her distance by one-fifth of its apparent amount if going with the same tide. Therefore, if in a current of any sort, due allowance must be made, and it should be remembered that more dependence can be placed upon a position fixed by simultaneous bearings or angles, when two or more objects are available, than by two bearings of a single object.

**151.** Sextant Angles between Three Known Objects.—This method, involving the solution of the *three-point problem*, will, if the objects be well chosen, give the most accurate results of any. It is largely employed in surveying, because of its precision; and it is especially valuable in navigation, because it is not subject to errors arising from imperfect knowledge of the compass error, improper logging, or the effects of current, as are the methods previously described.

Three objects represented on the chart are selected and the angles measured with sextants of known index error between the center one and each of the others. Preferably there should be two observers and the two angles be taken simultaneously, but one observer may first take the angle which is changing more slowly, then take the other, then repeat the first angle, and consider the mean of the first and last observations as the value of the first angle. The position is usually plotted by means of the three-armed protractor, or station-pointer (see art. 432, Chap. XVII). Set the right and left angles on the instrument, and then move it over the chart until the three beveled edges pass respectively and simultaneously through the three objects. The center of the instrument will then mark the ship's position, which may be pricked on the chart or marked with a pencil point through the center hole. When the three-armed protractor is not at hand, the tracing-paper protractor will prove an excellent substitute, and may in some cases be preferable to it, as, for instance, when the objects angled on are so near the observer as to be hidden by the circle of the instrument. A graduated circle printed upon tracing paper permits the angles being readily laid off, but a plain piece of tracing paper may be used and the angles marked by means of a small protractor. The tracing-paper protractor permits the laying down, for simultaneous trial, of a number of angles, where special accuracy is sought.

**152.** The three-point problem, by which results are obtained in this method, is: To find a point such that three lines drawn from this point to three given points shall make given angles with each other.

Let A, B, and C, in figure 20, be three fixed objects on shore, and from the ship, at D, suppose the angles CDB and ADB are found equal, respectively, to 40° and 60°.

With the complement of CDB, 50°, draw the lines BE and CE; the point of intersection will be the center of a circle, on some point of whose circumference the ship must be. Then, with the complement of the angle ADB, 30°, draw the lines AF and BF, meeting at F, which point will be the center of another circle, on some point of whose circumference the ship must be. Then D, the point of intersection of the circumference of the two circles, will be the position of the ship.
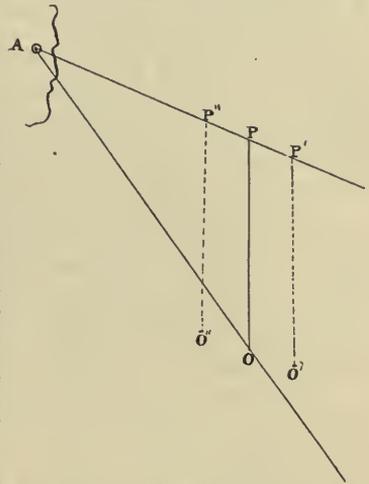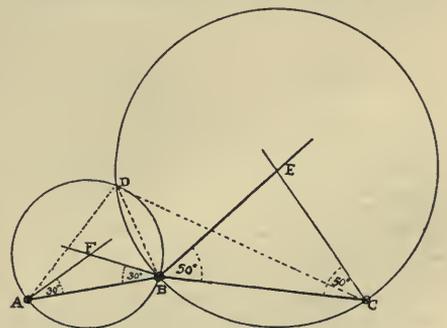


FIG. 20.

The correctness of this solution may be seen as follows: Take the first circle, DBC; in the triangle EBC, the angle at E, the center, equals $180° - 2 \times 50° = 2(90° - 50°)$, twice the complement of 50°, which is twice the observed angle; now if the angle at the center subtended by the chord BC equals twice the observed angle, then the angle at any point on the circumference subtended by that chord, which equals half the angle at the center, equals the observed angle; so the required condition is fulfilled. Should either of the angles exceed 90°, the excess of the angle over 90° must be laid off on the opposite side of the lines joining the stations.

**153.** It may be seen that the intersection of the circles becomes less sharp as the centers E and F approach each other; and finally that the problem becomes indeterminate when the centers coincide, that is, when the three observed points and the observer's position all fall upon the same circle; the two circles are then identical and there is no intersection; such a case is called a "revolver," because the protractor will revolve around the whole circle, everywhere passing through the observed points. The avoidance of the revolver and the employment of large angles and short distances form the keys to the selection of favorable objects.

Generally speaking, the observer, in judging which objects are the best to be taken, can picture in his eye the circle passing through the three points and note whether it comes near to his own position. If it does, he must reject one or more of the objects for another or others. It should be remembered that he must avoid not only the condition where the circle passes exactly through his position (when the problem is wholly indeterminate), but also all conditions approximating thereto, for in such cases the circles will intersect at a very acute angle, and the inevitable small errors of the observation and plotting will produce large errors in the resulting fix.

Without giving an analysis of reasons, which may be found in various works that treat the problem in detail, the following may be enumerated as the general conditions which result in a *good* fix:

(a) When the center object of the three lies between the observer and a line joining the other two, or lies nearer than either of the other two.

(b) When the sum of the right and left angles is equal to or greater than 180°.

(c) When two of the objects are in range, or nearly so, and the angle to the third is not less than 30°.

(d) When the three objects are in the same straight line.

A condition that limits all of these is that angles should be large—at least as large as 30°—excepting in the case where two objects are in range or nearly so, and then the other angle must be of good size. When possible, near objects should be used rather than distant ones. The navigator should not fall into the error of assuming that objects which would give good cuts for a cross bearing are necessarily favorable for the three-point solution.

In a revolver, the angle formed by lines drawn from the center object to the other two, added to the sum of the two observed angles, equals 180°. A knowledge of this fact may aid in the choice of objects.

If in doubt as to the accuracy with which the angles will plot, a third angle to a fourth object may be taken. Another way to make sure of a doubtful fix is to take one compass bearing, by means of which even a revolver may be made to give a good position.

**154.** THE DANGER ANGLE.—When running in sight of the land, it is frequently of the greatest importance for the navigator to assure himself that the course leads clear of outlying dangers, and the *Danger Angle* affords a convenient means of so doing. There are two sorts of danger angles—the horizontal angle taken between two objects, and the vertical angle of a single one. The former will be first described.

**155.** Suppose, in figure 21, that a vessel standing along the coast on the course indicated must pass an offshore danger between two well-marked objects, A and B, and that, allowing a safe margin, it is desired to approach no closer than the point O. Through the points A, B, and O draw a circle, by the usual methods of geometry, and observe that no portion of the danger lies without the circle. Measure the angle AOB with a protractor, and consider this the danger angle; as the ship draws near, take frequent observations with a sextant of the angle subtended by the objects A and B. As long as the angle is less than the danger angle the ship is without the circle; but if the angle increases to the amount of the danger angle, she is on the circle, and should at once sheer off to avoid approaching closer. The reason will be evident from the consideration that all angles AOB, AO'B, AO''B, AO'''B, subtended at points on the circumference of the circle by the chord AB, are equal.
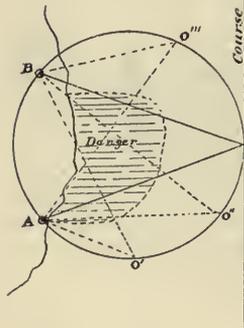


FIG. 21.

**156.** The vertical danger angle is an application of the same principle where there is in sight only one well-charted object and that is of known height. Draw a circle with that object as a center and of such radius that no neighboring dangers lie beyond its circumference; note, from Table 33, the vertical angle which is subtended by the known height at the distance chosen as a radius, and, by frequent observations in passing, make sure that this danger angle is not exceeded. By a simple modification, a ship passing *inshore* of an isolated rock or shoal could be navigated clear by means of a vertical danger angle which was not allowed to *decrease* below that corresponding to a safe distance.

Considerations governing the taking of vertical angles are given in the description of finding position by one bearing and the distance (arts. 139, 140).

**157.** THE DANGER BEARING.—This is a method by which the navigator is warned by a compass bearing when the course is leading into danger. Suppose a vessel to be steering a course, as indicated in figure 22, along a coast which must not be approached within a certain distance, the landmark A being a guide. Let the navigator draw through A the line
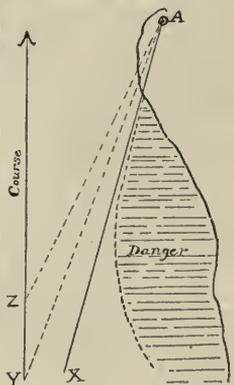


FIG. 22.

XA, clear of the danger at all points, and note its direction by the compass rose; then let frequent bearings be taken as the ship proceeds, and so long as the bearings, YA, ZA, are to the *right* of XA he may be assured that he is on the *left* or safe side of the line.

If, as in the case given, there is but one object in sight and that nearly ahead, it would be very difficult to get an exact position, but this method would always show whether or not the ship was on a good course, and would, in consequence, be of the greatest value. And even if there were other objects visible by which to get an accurate fix it would be a more simple matter to note, by an occasional glance over the sight-vane of the pelorus or compass, that the ship was making good a safe course than to be put to the necessity of plotting the position each time.

**158.** It will occasionally occur that two natural objects will so lie that when in range they mark a danger bearing; advantage should be taken of all such, as they are easier to observe than a compass bearing; but if in a locality with which the navigator has not had previous acquaintance the compass bearing of all ranges should be observed and compared with that indicated on the chart in order to make sure of the identity of the objects. The utility of ranges, either artificial or natural, as guides in navigation is well recognized.

**159.** SOUNDINGS.—The practice should be followed of employing one or two leadsmen to take and report soundings continuously while in shoal water or in the vicinity of dangers. The soundings must not be regarded as fixing a position, but they afford a check upon the positions obtained by other methods. An exact agreement with the soundings on the chart need not be expected, as there may be some little inaccuracies in reporting the depth on a ship moving with speed through the water, or the tide may cause a discrepancy, or the chart itself may lack perfection; but the soundings should agree in a general way, and a marked departure from the characteristic bottom shown on the chart should lead the navigator to verify his position and proceed with caution; especially is this true if the water is more shoal than expected.

**160.** But if the soundings in shallow water when landmarks are in sight serve merely as an auxiliary guide, those taken (usually with the patent sounding machine or deep-sea lead) when there exist no other means of locating the position, fulfill a much more important purpose. In thick weather, when approaching or running close to the land, and at all times when the vessel is in less than 100 fathoms of water and her position is in doubt, soundings should be taken continuously and at regular intervals, and, with the character of the bottom, systematically recorded. By laying the soundings on tracing paper, along a line which represents the track of the ship according to the scale of the chart, and then moving the paper over the chart, keeping the various courses parallel to the corresponding directions on the chart, until the observed soundings agree with those laid down, the ship's position will in general be quite well determined. While some localities, by the sharpness of the characteristics of their soundings, lend themselves better than others to accurate determinations by this method, there are few places where the mariner can not at least keep out of danger by the indications, even if they tell him no more than that the time has come when he must anchor or lie off till conditions are more favorable.

**161.** LIGHTS.—Before coming within range of a light the navigator should acquaint himself with its characteristics, so that when sighted it will be recognized. The charts, sailing directions, and light lists give information as to the color, character, and range of visibility of the various lights. Care should be taken to note all of these and compare them when the light is seen. If the light is of the flashing, revolving, or occulting variety the duration of its periods should be noted to identify it. If a fixed light, a method that may be employed to make sure that it is not a vessel's light is to descend several feet immediately after sighting it and observe if it disappears from view; a navigation light will usually do so, excepting in misty weather, while a vessel's light will not. The reason for this is that navigation lights are as a rule sufficiently powerful to be seen at the farthest point to which the ray can reach without being interrupted by the earth's curvature. They are therefore seen at the first moment that the ray reaches an observer on a ship's deck, and are cut off if he lowers the eye. A vessel's light, on the other hand, is usually limited by its intensity and does not carry beyond a distance within which it it is visible at all heights.

Care must be taken to avoid being deceived on first sighting a light, as there are various errors into which the inexperienced may fall. The glare of a powerful light is often seen beyond the distance of visibility of its direct rays by the reflection downward from particles of mist in the air; the same mist may also cause a white light to have a distinctly reddish tinge, or it may obscure a light except within short distances. When a light is picked up at the extreme limit at which the height of the observer will permit, a fixed light may appear flashing, as it is seen when the ship is on the crest of a wave, and lost when in the hollow.

Many lights are made to show different colors in different sectors within their range, and by consulting his chart or books, the navigator may be guided by the color of the ray in which he finds himself; in such lights one color is generally used on bearings whence the approach is clear, and another covers areas where dangers are to be encountered.

The visibility of lights is usually stated for an assumed height of the observer's eye of 15 feet, and must be modified accordingly for any other height. But it should be remembered that atmospheric and other conditions considerably affect the visibility, and it must not be positively assumed, on sighting a light, even in perfectly clear weather, that a vessel's distance is equal to the range of visibility; it may be either greater or less, as the path of a ray of light near the horizon receives extraordinary deflection under certain circumstances; the conditions governing this deflection are discussed in article 301, Chapter X.

**162.** BUOYS.—While buoys are valuable aids, the mariner should always employ a certain amount of caution in being guided by them. In the nature of things it is never possible to be certain of finding buoys in correct position, or, indeed, of finding them at all. Heavy seas, strong currents, ice, or collisions with passing vessels may drag them from their places or cause them to disappear entirely, and they are especially uncertain in unfrequented waters, or those of nations that do not keep a good lookout upon their aids to navigation. When, therefore, a buoy marks a place where a ship must be navigated with caution, it is well to have a danger angle or bearing as an additional guide instead of placing too much dependence upon the buoy being in place.

Different nations adopt different systems of coloring for their buoys; an important feature of many such systems, including those adopted by the United States and various other great maritime

nations (though not all), consists in placing black buoys to be left on the starboard hand of a vessel *going out* of a harbor or fairway, and red buoys (the color of the port side light) on the port hand.   In these various systems the color and character of the buoy are such as to denote the special purpose for which it is employed.

**163.** FOGS AND FOG SIGNALS.—As with lights, the navigator should, in a fog, acquaint himself with the characteristics of the various sound signals which he is likely to pick up, and when one is heard, its periods should be timed and compared with those given in the light lists to insure its proper identity.

Experiment has demonstrated that sound is conveyed through the atmosphere in a very uncertain way; that its intensity is not always increased as its origin is approached, and that areas within its range at one time will seem silent at another.   Add to these facts the possibility that, for some cause, the signal may not be working as it should be, and we have reason for observing the rule to proceed with the utmost caution when running near the land in a fog.

The best guide is the lead, and that should be kept going constantly.   The method of plotting soundings described in article 160 will give the most reliable position that is obtainable.   Moreover, the lead will warn the navigator of the approach to shallow water, when, if his position is at all in doubt, it is wisest to anchor before it becomes too late.

When running slowly in a fog (which caution, as well as the law, requires that one should do) it must be borne in mind that the relative effect of current is increased; for instance, the angle of deflection from the course caused by a cross-set is greater at low than at high speed.

It is worth remembering that when in the vicinity of a bold bluff shore vessels are sometimes warned of a too close approach by having their own fog signals echoed back from the cliffs; indeed, from a knowledge of the velocity of sound (art. 314, Chap. XI) it is possible to gain some rough idea of the distance in such a case.

**164.** TIDES AND CURRENTS. [a]—The information relating to the tides given on the chart and in other publications should be studied, as it is of importance for the navigator to know not only the height of the tide above the plane of reference of the chart, but also the direction and force of the tidal current.

The plane of reference adopted for soundings varies with different charts; on a large number it is that of mean low water, and as no plane of reference above that of mean low water is ever employed, the navigator may with safety refer his soundings to that level when in doubt.

When traversing waters in which the depth exceeds the vessel's draft by but a small margin, account must be taken of the fact that strong winds or a high barometer may cause the water to fall below even a very low plane of reference.   On coasts where there is much diurnal inequality in the tides, the amount of rise and fall can not be depended upon, and additional caution is necessary.

A careful distinction should be made between the vertical *rise and fall* of the tide, which is marked at the transition periods by a stationary height, or *stand*, and the tidal current, which is the horizontal transfer of water as a result of the difference of level, producing the *flood and ebb*, and the intermediate condition, or *slack*.   It seldom occurs that the turn of the tidal stream is exactly coincident with the high and low water, and in some channels the current may outlast the vertical movement which produces it by as much as three hours, the effect being that when the water is at a stand the tidal stream is at its maximum, and when the current is slack the rise or fall is going on with its greatest rapidity.   Care must be taken to avoid confounding the two.   Usually, more complete data is furnished in charts and tide tables regarding the rise and fall, and it frequently occurs that the information regarding the tidal current is comparatively meager; the mariner must therefore take every means to ascertain for himself the direction and force of the tidal and other currents, either from the set shown between successive well-located positions of the ship, or by noting the ripple of the water around buoys, islets, or shoals, the direction in which vessels at anchor are riding, and the various other visible effects of the current.

Current arrows on the chart must not be regarded as indicating absolutely the conditions that are to be encountered.   They represent the mean of the direction and force observed, but the observations upon which they are based may not be complete, or there may be reasons that bring about a departure from the normal state.

Generally speaking, the rise and fall and strength of current are at their minimum along straight stretches of coast upon the open ocean, while bays, bights, inlets, and large rivers operate to augment the tidal effects, and it is in the vicinity of these that one finds the highest tides and strongest currents.   The navigator need therefore not be surprised, in cruising along a coast, to notice that his vessel is set more strongly toward or from the shore in passing an indentation, and that the evidences of tide will appear more marked as he nears its mouth.

**165.** CHARTS. [b]—The chart should be carefully studied, and among other things all of its notes should be read, as valuable information may be given in the margin which it is not practicable to place upon the chart abreast the locality affected.

The mariner will do well to consider the source of his chart and the authority upon which it is based.   He will naturally feel the greatest confidence in a chart issued by the Government of one of the more important maritime nations which maintains a well-equipped office for the especial purpose of acquiring and treating hydrographic information.   He should note the character of the survey from which the chart has been constructed; and, finally, he should be especially careful that the chart is of recent issue or bears correction of a recent date—facts that should always be clearly shown upon its face.

It is well to proceed with caution when the chart of the locality is based upon an old survey, or one whose source does not carry with it the presumption of accuracy.   Even if the original survey was a good one, a sandy bottom, in a region where the currents are strong or the seas heavy, is liable to undergo in time marked changes; and where the depth is affected by the deposit or removal of silt, as in the vicinity of the estuaries of large river systems, the behavior is sometimes most capricious.   Large blank spaces on the chart, where no soundings are shown, may be taken as an indication that no sound-

---

[a] See also Chapter XX.                              [b] See also article 36 and following articles, Chapter II.

ings were made, and are to be regarded with suspicion, especially if the region abounds in reefs or pinnacle rocks, in which case only the the closest sort of a survey can be considered as revealing all the dangers. All of these facts must be duly weighed.

When navigating by landmarks the chart of the locality which is on the largest scale should be used. The hydrography and topography in such charts appear in greater detail, and—a most important consideration—bearings and angles may be plotted with increased accuracy.

**166.** RECORDS.—It will be found a profitable practice to pay careful attention to the recording of the various matter relating to the piloting of the ship. A notebook should be kept at hand on deck or on the bridge, in which are to be entered all bearings or angles taken to fix the position, all changes of course, important soundings, and any other facts bearing upon the navigation. (This book should be different from the one in which astronomical sights and offshore navigation are worked.) The entries, though in memorandum form, should be complete; it should be clear whether bearings and courses are true, magnetic, or by compass; and it is especially important that the time and patent log reading should be given for each item recorded. The value of this book will make itself apparent in various directions; it will afford accurate data for the writing of the ship's log; it will furnish interesting information for the next run over the same ground; it will provide a means by which, if the ship be shut in by fog, rain, or darkness, or if there be difficulty in recognizing landmarks ahead, the last accurate fix can be plotted and brought forward; and, finally, if there should be a mishap, the notebook would furnish evidence as to where the trouble has been.

The chart on which the work is done should also be made an intelligible record, and to this end the pencil marks and lines should not be needlessly numerous, heavy, or long. In plotting bearings, draw lines only long enough to cover the probable position. Mark intersections or positions by drawing a small circle around them, and writing neatly abreast them the time and patent log reading. Indicate the courses and danger bearings by full lines and mark them appropriately, preferably giving both magnetic (or true) and compass directions. A great number of lines extending in every direction may lead to confusion; however remote the chance may seem, the responsibilities of piloting are too serious to run even a small risk.

Finally, on anchoring, record and plot the position by bearings or angles taken after coming to; observe that the berth is a safe one, or, if in doubt, send a boat to sound in the vicinity of the ship to make sure.

6583—06——4

# CHAPTER V.

## THE SAILINGS.

**167.** In considering a ship's position at sea with reference to any other place, either one that has been left or one toward which the vessel is bound, five terms are involved—the *Course*, the *Distance*, the *Difference of Latitude*, the *Difference of Longitude*, and the *Departure*.[a] The solutions of the various problems that arise from the mutual relation of these quantities are called *Sailings*.

**168.** KINDS OF SAILINGS —When the only quantities involved are the course, distance, difference of latitude, and departure, the process is denominated *Plane Sailing*. In this method the earth is regarded as a plane, and the operation proceeds as if the vessel sailed always on a perfectly level surface. When two or more courses are thus considered, they are combined by the method of *Traverse Sailing*. It is evident that the number of *miles* of latitude and departure can thus be readily deduced; but, while one mile always equals one minute in difference of latitude, one mile of departure corresponds to a difference of longitude that will vary with the latitude in which the vessel is sailing. Plane sailing, therefore, furnishes no solution where difference of longitude is considered, and for such solution resort must be had to one of several methods, which, by reason of their taking account of the spherical figure of the earth, are called *Spherical Sailings*.

When a vessel sails on an east or west course along a parallel of latitude, the method of converting departure into difference of longitude is called *Parallel Sailing*. When the course is not east or west, and thus carries the vessel through various latitudes, the conversion may be made either by *Middle Latitude Sailing*, in which it is assumed that the whole run has been made in the mean latitude, or by *Mercator Sailing*, in which the principle involved in the construction of the Mercator chart (art. 38, Chap. II) is utilized.

*Great Circle Sailing* deals with the courses and distances between any two points when the track followed is a great circle of the terrestial sphere. A modification of this method which is adopted under certain circumstances is called *Composite Sailing*.

### PLANE SAILING.



FIG. 23.

**169.** In Plane Sailing, the curvature of the earth being neglected, the relation between the elements of the rhumb track joining any two points may be considered from the plane right triangle formed by the meridian of the place left, the parallel of the place arrived at, and the rhumb line. In figure 23, T is the point of departure; T′, the point of destination; T$n$, the meridian of departure; T′$n$, the parallel of destination; and TT′, the rhumb line between the points. Let C represent the course, T′T$n$; Dist., the distance, TT′; DL, the difference of latitude, T$n$; and Dep., the departure, T′$n$. Then from the triangle TT′$n$, we have the following:
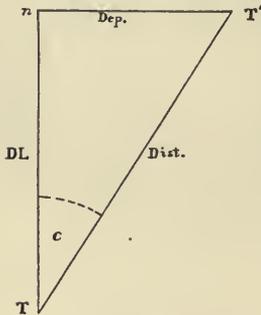
$$\sin C = \frac{\text{Dep.}}{\text{Dist.}};$$

$$\cos C = \frac{D\,L}{\text{Dist.}};$$

$$\tan C = \frac{\text{Dep.}}{D\,L}.$$

From these equations are derived the following formulæ for working the various problems that may arise in Plane Sailing:

| Given. | Required. | | Formulæ. |
|---|---|---|---|
| Course and distance ..... | { Difference of latitude ... | D L = Dist. cos C. | Log D L = log Dist. + log cos C. |
| | Departure .............. | Dep. = Dist. sin C. | Log Dep. = log Dist. + log sin C. |
| Difference of latitude and departure. | { Course ................. | Tan C = $\frac{\text{Dep.}}{D\,L}$. | Log tan C = log Dep. − log D L. |
| | Distance............... | Dist. = $\frac{\text{Dep.}}{\sin C}$. | Log Dist. = log Dep. − log sin C. |
| Course and difference of latitude. | { Distance.............. | Dist. = $\frac{D\,L}{\cos C}$. | Log Dist. = log D L − log cos C. |
| | Departure ............. | Dep. = D L tan C. | Log Dep. = log D L + log tan C. |

[a] For the definition of these terms, see article 6, Chapter I.

| Given. | Required. | | Formulæ. |
|---|---|---|---|
| Course and departure.... | Distance............... | Dist. $=\dfrac{\text{Dep.}}{\sin \text{C}}$. | Log Dist. $=$ log Dep. $-$ log sin C. |
| | Difference of latitude... | D L $=\dfrac{\text{Dep.}}{\tan \text{C}}$. | Log D L $=$ log Dep. $-$ log tan C. |
| Distance and difference of latitude. | Course ............... | Cos C $=\dfrac{\text{D L}}{\text{Dist.}}$. | Log cos C $=$ log D L $-$ log Dist. |
| | Departure ............ | Dep. $=$ Dist. sin C. | Log Dep. $=$ log Dist. $+$ log sin C. |
| Distance and departure.. | Course ............... | Sin C $=\dfrac{\text{Dep.}}{\text{Dist.}}$. | Log sin C $=$ log Dep. $-$ log Dist. |
| | Difference of latitude... | D L $=$ Dist. cos C. | Log D L $=$ log Dist. $+$ log cos C. |

**170.** The solution of the plane right triangle may be accomplished either by Plane Trigonometry, by Traverse Tables, or by construction. If the former method is adopted, the logarithms of numbers may be found in Table 42, and of the functions of angles in Table 44. A more expeditious method is available, however, in the Traverse Tables, which give by inspection the various solutions. Table 1 contains values of the various parts for each unit of Dist. from 1 to 300, and for each quarter-point (2° 49′), of C; Table 2 contains values for each unit of Dist. from 1 to 600, and for each degree of C. The method of solving by construction consists in laying down the various given terms by scale upon a chart or plain paper, and measuring thereon the terms required.

**171.** Of the various problems that may arise, the first two given in the foregoing table are of much the most frequent occurrence. In the first, the given quantities are course and distance, and those to be found are difference of latitude and departure; this is the case where a navigator, knowing the distance run on a given course, desires to ascertain the amount made good to north or south and to east or west. In the second case the conditions are reversed; this arises where the course and distance between two points are to be obtained from their known difference of latitude and departure.

EXAMPLE: A ship sails SW. by W., 244 miles. Required the difference of latitude and the departure made good.

*By Computation.*

| Dist. | 244 | log | 2.38739 |
|---|---|---|---|
| C | 56° 15′ | log cos | 9.74474 |
| DL | 135.6 | log | 2.13213 |

| Dist. | 244 | log | 2.38739 |
|---|---|---|---|
| C | 56° 15′ | log sin | 9.91985 |
| Dep. | 202.9 | log | 2.30724 |

*By Inspection.*

In Table 1, find the course SW. by W. (5 points); it occurs at the bottom of the page, therefore take the names of the columns from the bottom as well; opposite 244 in the Dist. column will be seen Lat. 135.6 and Dep. 202.9.

EXAMPLE: A ship sails N. 5° E., 188 miles. Required the difference of latitude and the departure.

*By Computation.*

| Dist. | 188 | log | 2.27416 |
|---|---|---|---|
| C | 5° | log cos | 9.99834 |
| DL | 187.3 | log | 2.27250 |

| Dist. | 188 | log | 2.27416 |
|---|---|---|---|
| C | 5° | log sin | 8.94030 |
| Dep. | 16.4 | log | 1.21446 |

*By Inspection.*

In Table 2, find the course 5°; it occurs at the top of the page, therefore take the names of the columns from the top; opposite 188 in the Dist. column will be seen Lat. 187.3 and Dep. 16.4.

EXAMPLE: A vessel is bound to a port which is 136 miles to the north and 203 miles to the west of her position. Required the course and distance.

*By Computation.*

| Dep. | 203 | log | 2.30750 |
|---|---|---|---|
| DL | 136 | log | 2.13354 |
| C | (N.) 56° 11′ (W.) | log tan | 0.17396 |
| Dep. | 203 | log | 2.30750 |
| C | 56° 11′ | log sin | 9.91951 |
| Dist. | 244.3 | log | 2.38799 |

*By Inspection.*

Enter Table 1 and turn the pages until a course is found whereon the numbers 136 and 203 are found abreast each other in the columns marked respectively Lat. and Dep. This occurs most nearly at the course for 5 points, the angle being taken from the bottom, because the appropriate names of the columns are found there. The course is therefore NW. by W. Interpolating for intermediate values, the corresponding number in the Dist. column is about 244.3.

EXAMPLE: As the result of a day's run a vessel changes latitude 244 miles to the south and makes a departure of 171 miles to the east.   What is the course and distance made good?

|  | *By Computation.* | | | | | *By Inspection.* |

| | | | | |
|---|---|---|---|---|
| Dep. | 171 | log | 2.23300 | |
| DL | 244 | log | 2.38739 | |
| C | (S.) 35° 02′ (E.) | log tan | 9.84561 | • |
| Dep. | 171 | log | 2.23300 | |
| C | 35° 02′ | log sin | 9.75895 | |
| Dist. | 297.9 | log | 2.47405 | |

Enter Table 2 and the nearest agreement will be found on course (S.) 35° (E.), the appropriate names being found at the top of the page.   The nearest corresponding Dist. is 298 miles.

## TRAVERSE SAILING.

**172.** A *Traverse* is an irregular track made by a ship in sailing on several different courses, and the method of *Traverse Sailing* consists in finding the difference of latitude and departure corresponding to several courses and distances and reducing all to a single equivalent course and distance.   This is done by determining the distance to north or south and to east or west made good on each course, taking the algebraic sum of these various differences of latitude and departure and finding the course and distance corresponding thereto.   The work can be most expeditiously performed by adopting a tabular form for the computation and using the traverse tables.

EXAMPLE: A ship sails SSE., 15 miles; SE., 34 miles; W. by S., 16 miles; WNW., 39 miles; S. by E., 40 miles.   Required the course and distance made good.

| Courses. | Dist. | N. | S. | E. | W. |
|---|---|---|---|---|---|
| SSE. | 15 | | 13.9 | 5.7 | |
| SE. | 34 | | 24.0 | 24.0 | |
| W. by S. | 16 | | 3.1 | | 15.7 |
| WNW. | 39 | 14.9 | | | 36.0 |
| S. by E. | 40 | | 39.2 | 7.8 | |
| | | 14.9 | 80.2 | 37.5 | 51.7 |
| | | | 14.9 | | 37.5 |
| S. by W. | 66.8 | | 65.3 | | 14.2 |

The result of the various courses is, therefore, to carry the vessel S. by W., 66.8 miles from her original position.

## PARALLEL SAILING.

**173.** Thus far the earth has been regarded as an extended plane, and its spherical figure has not been taken into account; it has thus been impossible to consider one of the important terms involved—namely, difference of longitude.   *Parallel Sailing* is the simplest of the various forms of Spherical Sailing, being the method of interconverting departure and difference of longitude when the ship sails upon an east or west course, and therefore remains always on the same parallel of latitude.

In figure 24 T and T′ are two places in the same latitude; P, the adjacent pole; TT′, the arc of the parallel of latitude through the two places; MM′, the corresponding arc of the equator intercepted between their meridians PM and PM′; and TT′, the departure on the parallel whose latitude is TCM = OTC, and whose radius is OT.

Let DLo represent the arc of the equator MM′, which is the measure of MPM′, the difference of longitude of the meridians PM and PM′; R, the equatorial radius of the earth, CM = CT; r, the radius OT of the parallel TT′; and L, the latitude of that parallel.

Then, since TT′ and MM′ are similar arcs of two circles, and are therefore proportional to the radii of the circles, we have:

$$\frac{TT'}{MM'} = \frac{OT}{CM}; \text{ or, } \frac{Dep.}{DLo} = \frac{r}{R}.$$

FIG. 24.

From the triangle COT, $r = R \cos L$; hence

$$\frac{Dep.}{DLo} = \frac{R \cos L}{R}; \text{ or, DLo} = Dep. \sec. L; \text{ or, Dep.} = DLo \cos L.$$

Thus the relations are expressed between *minutes* of longitude and *miles* of departure.

**174.** Two cases arise under Parallel Sailing: First, where the difference of longitude between two places on the same parallel is given, to find the departure; and, second, where the departure is given, to find the difference of longitude. ·
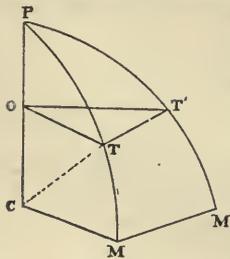
In working these problems, the computation can be made by logarithms; but the traverse tables may more conveniently be employed. Remembering that those tables are based upon the formulæ,

$$DL = Dist. \cos C, \text{ and } Dist. = DL \sec C,$$

we may substitute for the column marked Lat. the departure, for that marked Dist. the difference of longitude, and for the courses at top and bottom of the page the latitude. The tables then become available for making the required conversions.

EXAMPLE: A ship in the latitude of 49° 30′ sails directly east until making good a difference of longitude of 3° 30′. Required the departure.

*By Computation.*

| | | | |
|---|---|---|---|
| L | 49° 30′ | log cos | 9.81254 |
| DLo | 210′ | log | 2.32222 |
| Dep. | 136.4 | log | 2.13476 |

*By Inspection.*

Enter Table 2 with the latitude as C and the difference of longitude as Dist. As the table is calculated only to single degrees, we must find the numbers in the pages of 49° and 50° and take the mean. Corresponding to Dist. 210 in the former is Lat. 137.8, and in the latter Lat. 135.0. The mean, which is the required departure, is 136.4.

EXAMPLE: A ship in the latitude of 38° sails due west a distance of 215.5 miles. Required the difference of longitude.

*By Computation.*

| | | | |
|---|---|---|---|
| L | 38° | log sec | 0.10347 |
| Dep. | 215.5 | log | 2.33345 |
| DLo $\begin{cases} 273'.5 \\ 4° 33'.5 \end{cases}$ | | log | 2.43692 |

*By Inspection.*

Entering Table 2 with the latitude, 38°, as a course, corresponding with the number 215.5 in column of Lat., is 273.5 in the column of Dist. This is therefore the required difference of longitude, being equal to 4° 33′.5.

## MIDDLE LATITUDE SAILING.

**175.** When a ship follows a course obliquely across the meridian the latitude is constantly changing, and the method of converting departure and difference of longitude by Parallel Sailing, just described, ceases to be applicable.

In figure 25, T is the point of departure; T′, the point of destination; P, the earth's pole; TT′, the rhumb track; $Tn$, $n_1T'$, the course; $Tn$, $n_1T'$, the respective parallels of latitude; and MM′, the equator.

The difference of longitude between T and T′ is MPM′, which may be measured by the arc of the equator, MM′, intercepted between their meridians. This corresponds to a departure $Tn$ in the latitude of T, and to the smaller departure $T'n_1$ in the higher latitude of T′; but since the vessel neither makes all of the departure in the latitude T, nor all of it in the latitude T′, the departure actually made in the passage must have some intermediate value between these extremes. Dividing the total difference of longitude into a number of equal parts $MPm_1$, $m_1Pm_2$, etc., of such small extent that, for the purposes of conversion, the change of latitude corresponding to each may be neglected, we have the total departure made up of the sum of a number of small departures, each equal to the same difference of longitude, but each different from the other. These will be $d_1 r_1$ in the latitude T, $d_2 r_2$ in the latitude $r_1$, etc. Hence we have:

$$MM' = d_1 r_1 \sec MT + d_2 r_2, \sec m_1 r_1 + d_3 r_3, \sec m_2 r_2, + \text{etc.}$$



FIG. 25.

Now, if LL′ be a parallel of latitude lying midway between $Tn$ and $T'n_1$, since there will be as many of the small parts lying above as below it, and since for moderate distances the ratio to be employed in the conversion of departure and difference of longitude may be regarded as varying directly with the latitude, it may be assumed for such distances that the sum of all of the different small departures equals the single departure between the meridians measured in the latitude LL′, and therefore that the departure obtained by the method of plane sailing on any course may be converted into difference of longitude by multiplying by the secant of the Middle Latitude.

The method of conversion based upon this assumption is denominated *Middle Latitude Sailing*, and by reason of its convenience and simplicity is usually employed for short distances, such as those covered by a vessel in a day's run.

**176.** In Middle Latitude Sailing, having found the mean of the latitudes, the solution is identical with that of Parallel Sailing (art. 173), substituting the Middle Latitude for the single latitude therein employed.

**177.** It may be remarked that the Middle Latitude should not be used when the latitudes are of opposite name; if of different names and the distance is small, the departure may be assumed equal to the difference of longitude, since the meridians are sensibly parallel near the equator; but if the distance is great the two portions of the track on opposites of the equator must be treated separately.

EXAMPLE: A ship in Lat. 42° 30′ N., Long. 58° 51′ W., sails SE. by S., 300 miles. Required the latitude and longitude arrived at.

From Table 1: Course SE. by S., Dist., 300, we find Lat., 249.4 S. (4° 09′.4), Dep., 166.7 E.

| | | | | | |
|---|---|---|---|---|---|
| Latitude left, | 42° 30′.0 N. | | Latitude left, | 42° 30′ N. |
| DL, | 4 09 .4 S. | | Latitude arrived at, | 38 21 N. |
| Latitude arrived at, | 38 20 .6 N. | | 2)80 51 |
| | | | Mid. latitude, | 40 25 N. |

Enter Table 2 with the middle latitude, 40°, as a course; the difference of longitude (Dist.) corresponding to the departure (Lat.) 166.7 is 217.6; entering with 41°, it is 220.9; the mean is 219.2 (3° 39'.2).

| | |
|---|---|
| Longitude left, | 58° 51'.0 W. |
| DLo, | 3  39 .2 E. |

Longitude arrived at, 55  11 .8 W.

EXAMPLE: A ship in Lat. 39° 42' S., Long. 3° 31' E., sails S. 42° W., 236 miles. Required the latitude and longitude arrived at.

From Table 2: Course, S. 42° W., Dist., 236 miles; we find Lat., 175.4 S. (2° 55'.4), Dep., 157.9 W.

| | | | |
|---|---|---|---|
| Latitude left, | 39° 42'.0 S. | Latitude left, | 39° 42' S. |
| DL, | 2  55 .4 S. | Latitude arrived at, | 42  37  S. |

| | |
|---|---|
| Latitude arrived at, 42  37 .4 S. | 2)82  19 |

Mid. latitude,  41  09  S.

From Table 2: Mid. Lat. (course), 41°, Dep. (Lat.), 157.9; we find DLo (Dist.), 209.3 (3° 29'.3).

| | |
|---|---|
| Longitude left, | 3° 31'.0 E. |
| DLo, | 3  29 .3 W. |

Longitude arrived at, 0  01 .7 E.

EXAMPLE: A vessel leaves Lat. 49° 57' N., Long. 15° 16' W., and arrives at Lat. 47° 18' N., Long. 20° 10' W. Required the course and distance made good.

| | | | |
|---|---|---|---|
| Latitude left, | 49° 57' N. | Longitude left, | 15° 16' W. |
| Latitude arrived at, | 47  18  N. | Longitude arrived at, | 20  10  W. |
| DL, | $\left\{ \begin{array}{c} 2°\ 39' \\ 159' \end{array} \right\}$ S. | DLo, | $\left\{ \begin{array}{c} 4°\ 54' \\ 294' \end{array} \right\}$ W. |
| Mid. latitude, | 2)97° 15' N.<br>48  38  N. | | |

From Table 2: Mid. Lat. (course), 49°, DLo (Dist.), 294; we find Dep. (Lat.), 192.9.
From Table 2: DL 159 S., Dep. 192.9 W., we find course S. 51° W., Dist., 251 miles.

**178.** The assumption upon which Middle Latitude sailing is based—that the conversion may be made as if the whole distance were sailed upon a parallel midway between the latitudes of departure and destination—while sufficiently accurate for moderate distances, may be materially in error where the distances are large. In such case, either the method of Mercator Sailing (art. 179) must be employed, or else the correction given in the following table should be applied to the mean latitude to obtain what may be termed the latitude of conversion, being that latitude in which the required conditions are accurately fulfilled. The table is computed from the formula:

$$\cos L_C = \frac{l}{m},$$

where $L_C$ represents the latitude of conversion, and $l$ and $m$ are respectively the differences of latitude and of meridional parts (art. 39, Chap. II) between the latitudes of departure and destination.[a]

| Mid. Lat. | Difference of latitude. | | | | | | | | | | | | | | | Mid. Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 12° | 14° | 16° | 18° | 20° | |
| ° | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ' | ° |
| 15 | −86 | −85 | −84 | −83 | −81 | −79 | −76 | −73 | −69 | −65 | −56 | −46 | −34 | −21 | − 6 | 15 |
| 18 | −67 | −67 | −66 | −65 | −63 | −61 | −59 | −56 | −53 | −50 | −43 | −34 | −23 | −12 | 1 | 18 |
| 21 | −54 | −54 | −53 | −52 | −51 | −49 | −47 | −44 | −42 | −39 | −32 | −24 | −15 | − 5 | 7 | 21 |
| 24 | −44 | −44 | −44 | −42 | −41 | −40 | −38 | −36 | −33 | −31 | −24 | −17 | − 8 | 1 | 12 | 24 |
| 30 | −31 | −30 | −29 | −29 | −28 | −26 | −24 | −23 | −20 | −18 | −12 | − 6 | 1 | 11 | 21 | 30 |
| 35 | −23 | −22 | −21 | −21 | −19 | −18 | −17 | −15 | −12 | −10 | − 5 | 2 | 10 | 18 | 28 | 35 |
| 40 | −17 | −16 | −15 | −14 | −13 | −12 | −10 | − 8 | − 6 | − 4 | 2 | 8 | 16 | 25 | 34 | 40 |
| 45 | −12 | −11 | −11 | −10 | − 8 | − 7 | − 5 | − 3 | − 1 | 1 | 7 | 14 | 22 | 31 | 41 | 45 |
| 50 | − 8 | − 8 | − 7 | − 6 | − 5 | − 3 | − 1 | 1 | 3 | 6 | 12 | 20 | 28 | 38 | 49 | 50 |
| 55 | − 5 | − 5 | − 4 | − 3 | − 2 | 0 | 2 | 5 | 7 | 10 | 17 | 25 | 35 | 46 | 58 | 55 |
| 58 | − 4 | − 3 | − 3 | − 1 | 0 | 2 | 4 | 7 | 10 | 13 | 20 | 29 | 39 | 51 | 64 | 58 |
| 60 | − 3 | − 3 | − 2 | − 1 | . 1 | 3 | 5 | 8 | 11 | 14 | 22 | 32 | 43 | 55 | 69 | 60 |
| 62 | − 3 | − 2 | − 1 | 0 | 2 | 4 | 7 | 9 | 13 | 17 | 25 | 35 | 46 | 60 | 75 | 62 |
| 64 | − 2 | − 1 | 0 | 1 | 3 | 5 | 8 | 11 | 14 | 18 | 27 | 38 | 50 | 65 | 81 | 64 |
| 66 | − 2 | − 1 | 0 | 2 | 4 | 6 | 9 | 12 | 16 | 20 | 30 | 42 | 55 | 71 | 89 | 66 |
| 68 | − 1 | 0 | 1 | 2 | 5 | 7 | 10 | 14 | 18 | 22 | 33 | 46 | 61 | 78 | 98 | 68 |
| 70 | − 1 | 0 | 1 | 3 | 5 | 8 | 12 | 16 | 20 | 25 | 37 | 51 | 67 | 87 | 109 | 70 |
| 72 | 0 | 0 | 2 | 4 | 6 | 10 | 13 | 18 | 23 | 28 | 41 | 57 | 76 | 97 | 123 | 72 |

[a] The statement often made, that the latitude of conversion is always greater than the middle latitude, is not correct when the compression of the earth is taken into account, as an inspection of the table will show; that statement is based upon an assumption that the earth is a perfect sphere, and it was upon that assumption that a table which appeared in early editions of this work was computed. The value of the compression adopted for this table is $\frac{1}{293.465}$.

EXAMPLE: A vessel sails from Lat. 10° 13′ S. to Lat. 20° 21′ S., making a departure of 432 miles. Required the difference of longitude.

| | | | |
|---|---|---|---|
| Latitude left, | 10° | 13′ | S. |
| Latitude arrived at, | 20 | 21 | S. |

2)30  34     For Mid. Lat. 15° and Diff. of Lat. 10°, Correction, −65′.

| | | | |
|---|---|---|---|
| Mid. latitude, | 15 | 17 | S. |
| Correction, | − 1 | 05 | |
| L$_c$, | 14 | 12 | S. |

| | | | | |
|---|---|---|---|---|
| L$_c$ | 14° | 12′ | log sec | .01348 |
| Dep. | | 432 | log | 2.63548 |
| DLo | | 445′.6 | log | 2.64896 |

## MERCATOR SAILING.

**179.** *Mercator Sailing* is the method by which values of the various elements are determined from considering them in the relation in which they are plotted upon a chart constucted according to the Mercator projection.

**180.** Upon the Mercator chart (art. 38, Chap. II), the meridians being parallel, the arc of a parallel of latitude is shown as equal to the corresponding arc of the equator; the length of every such arc is, therefore, expanded; and, in order that the rhumb line may appear as a straight line, the meridians are also expanded by such amount as is necessary to preserve, in any latitude, the proper proportion existing between a unit of latitude and a unit of longitude. The lengths of small portions of the meridian thus increased are called *meridional parts* (art. 39, Chap. II), and these, computed for every minute of latitude from 0° to 80°, form the Table of Meridional Parts (Table 3), by means of which a Mercator chart may be constructed and all problems of Mercator Sailing may be solved.

In the triangle ABC (fig. 26), the angle ACB is the course, C; the side AC, the distance, Dist.; the side BC, the difference of latitude, DL; and the side AB, the departure, Dep. Then corresponding to the difference of latitude BC in the latitude under consideration, if CE be laid off to represent the meridional difference of latitude, *m*, completing the right triangle CEF, EF will represent the difference of longitude, DLo. The triangle ABC gives the relations involved in Plane Sailing as previously described; the triangle CEF affords the means for the conversion of departure and difference of longitude by Mercator Sailing.

**181.** To find the arc of the expanded meridian intercepted between any two parallels, or the *meridional difference of latitude*, when both places are on the same side of the equator, subtract the meridional parts of the lesser latitude, as given by Table 3, from the meridional parts of the greater: the remainder will be the meridional difference of latitude; but if the places are on different sides of the equator, the sum of the meridional parts will be the meridional difference of latitude.



FIG. 26.

**182.** To solve the triangle CEF by the traverse tables it is only necessary to substitute meridional difference for Lat., and difference of longitude for Dep. Where long distances are involved, carrying the computation beyond the limits of the traverse table, as frequently occurs in this method, either of two means may be adopted: the problems may be worked by the trigonometrical formulæ, using logarithms, or the given quantities involved may all be reduced by a common divisor until they fall within the traverse table, and the results, when obtained, correspondingly increased. The former method is generally preferable, especially when the distances are quite large and accurate results are sought. The formulæ for the various conversions are as follows:

$$\tan C = \frac{DLo}{m}; \quad DLo = m \tan C; \quad m = DLo \cot C.$$

EXAMPLE: A ship in Lat. 42° 30′ N., Long. 58° 51′ W., sails SE. by S., 300 miles. Required the latitude and longitude arrived at.

From Table 1: Course, SE. by S., Dist., 300; we find Lat. 249.4 S. (4° 09.′4).

| | | |
|---|---|---|
| Latitude left, | 42° 30′.0 N. | Merid. parts, +2806.4 |
| DL, | 4 09 .4 S. | |
| Latitude arrived at, | 38 20 .6 N. | Merid. parts, −2480.4 |
| | *m,* | 326.0 |

*By Computation.*

| | | | |
|---|---|---|---|
| *m* | 326.0 | log | 2.51322 |
| C | 33° 45′ | log tan | 9.82489 |
| DLo | { 217′.8 <br> { 3° 37′.8 | log | 2.33811 |

*By Inspection.*

Enter Table 1, course 3 points; since the quantities involved exceed the limits of the table, divide by 2; abreast $\frac{m}{2}$ (Lat.), 163.0, find $\frac{DLo}{2}$ (Dep.), 108.9; hence DLo = 217′.8 or 3° 37′.8.

| | |
|---|---|
| Longitude left, | 58° 51′.0 W. |
| DLo, | 3 37 .8 E. |
| Longitude arrived at, | 55 13 .2 W. |
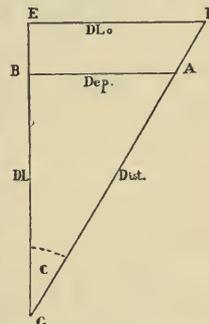
EXAMPLE: A ship in Lat. 4° 37′ S., Long. 21° 05′ W., sails N. 14° W., 450 miles. Required the latitude and longitude arrived at.

From Table 2: Course, (N.) 14° (W.), Dist., 450; we find Lat. 436.6 N. (7° 16′.6).

|  |  |  |  |
|---|---|---|---|
| Latitude left, | 4° 37′.0 S. | Merid. parts, | +275.4 |
| DL, | 7  16 .6 N. |  |  |
| Latitude arrived at, | 2  39 .6 N. | Merid. parts, | +159.0 |
|  |  | $m$, | 434.4 |

|  | *By Computation.* | | *By Inspection.* |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| $m$ | 434.4 | log | 2.63789 | From Table 2: Course, 14°, $m$ (Lat.), 434.4, we find |
| C | 14° | log tan | 9.39677 | DLo (Dep.) 108′.3 W., or 1° 48′.3. |
| DLo | $\begin{cases} 108′.3 \\ 1° 48′.3 \end{cases}$ | log | 2.03466 |  |

|  |  |
|---|---|
| Longitude left, | 21° 05′.0 W. |
| DLo, | 1  48 .3 W. |
| Longitude arrived at, | 22  53 .3 W. |

EXAMPLE: Required the course and distance by rhumb line from a point in Lat. 42° 03′ N., Long. 70° 04′ W., to another in Lat. 36° 59′ N., Long. 25° 10′ W.

| | | | | | |
|---|---|---|---|---|---|
| Lat. departure, | 42° 03′ N. | Merid. pts., | +2770.1 | Long. departure, | 70° 04′ W. |
| Lat. destination, | 36  59  N. | Merid. pts., | −2377.3 | Long. destination, | 25  10  W. |
| DL $\begin{cases} 5° 04′ \\ 304′ \end{cases}$S. |  | $m$, | 392.8 | DLo $\begin{cases} 44° 54′ \\ 2694′ \end{cases}$E. |  |
|  | DLo  2694 | log | 3.43040 |  |  |
|  | $m$　  392.8 | log | 2.59417 |  |  |
|  | C (S.) 81° 42′ (E.) | log tan | .83623 | log sec  .84056 |  |
|  | DL　　  304′ |  |  | log　  2.48287 |  |
|  | Dist.　  2106 |  | log | 3.32343 |  |

The course is therefore S. 81° 42′ E., and the distance is 2,106 miles. Since the figures involved are so large, it is best to employ only the method by computation. The formula by which the Dist. is obtained comes from Plane Sailing.

## GREAT CIRCLE SAILING.

**183.** The shortest distance between any two points on the earth's surface is measured by the arc of the great circle which passes through those points; and the method of sailing in which the arc of a great circle is employed for the track of the vessel, taking advantage of the fact that it is the shortest route possible, is denominated *Great Circle Sailing.*

**184.** It frequently happens when a great circle route is laid down that it is found to lead across the land, or to carry the vessel into a region of dangerous navigation or extreme cold which it is expedient to avoid; in such a case a certain parallel should be fixed upon as a limit of latitude, and a route laid down such that a great circle is followed as far as the limiting parallel, then the parallel itself, and finally another great circle to the port of destination. Such a modification of the great circle method is called *Composite Sailing.*

**185.** The *rhumb line* (art. 6, Chap. I) also called the *loxodromic curve*, which cuts all the meridians at the same angle, has been largely employed as a track by navigators on account of the ease with which it may be laid down on a Mercator chart. But as it is a longer line than the great circle between the same points, intelligent navigators of the present day use the latter wherever practicable. On the Mercator chart, however, the arc of a great circle joining two points (unless both are on the equator or both on the same meridian) will not be projected as a straight line, but as a curve which seems to be longer than the rhumb line; hence the shortest route appears as a circuitous one, and this is doubtless the reason that a wider use of the great circle has not been made.

It should be clearly understood that it is the rhumb line which is in fact the indirect route, and that in following the great circle the vessel is always heading for her port, exactly as if it were in sight, while on the course which is shown as a straight line on the Mercator chart the vessel never heads for her port until at the very end of the voyage.

**186.** The method of great circle sailing is of especial value to steamers, as such vessels need not, in the choice of a route, have regard for the winds to the same extent as must a sailing vessel; but even in navigating vessels under sail a knowledge of the great circle course may prove of great value. For example, suppose a ship to be bound from Sydney to Valparaiso; the first great circle course is SE. by S., while the Mercator course is almost due east. The distance is 748 miles shorter by the former route (if the

great circle is followed throughout, though this would lead to a latitude of 61° S.). With the wind at E. ½ S. the ship would lie nearer to the Mercator course on the starboard tack, assuming that she sailed within six points of the wind; but if she took that tack she would be increasing her distance from the port of destination by 4½ miles in every 10 that she sailed; while on the port tack, heading one point farther from the rhumb, the gain toward the port would be 9½ miles out of every 10. Any course between East and SSW. would be better than the Mercator course; and if the wind were anything to the eastward of SE. by S., the ship would gain by taking the port tack in preference to the starboard.

**187.** As the great circle makes a different angle with each meridian that is crossed, it becomes necessary to make frequent changes of the ship's course; in practice, the course is a series of chords joining the various points on the track line.

If, while endeavoring to follow a great circle, the ship is driven from it, as by unfavorable weather, it will not serve the purpose to return to the old track at convenience, but it is required that another great circle be laid down, joining the actual position in which the ship finds herself with the port of destination.

**188.** The methods of determining the great circle course may be divided generally into four classes; namely, by *Great Circle Sailing Charts*, by *Computation*, by the methods of the *Time Azimuth*, and by *Graphic Approximations.*

**189.** GREAT CIRCLE SAILING CHARTS.—Of the available methods, that by means of charts especially constructed for the purpose is considered greatly superior to all others.

A series of great circle sailing charts covering the navigable waters of the globe is published by the United States Hydrographic Office. Being on the gnomonic projection (art. 43, Chap. II), all great circles are represented as straight lines, and it is only necessary to join any two points by such a line to represent the great circle track between them. The courses and distance are readily obtainable by a method explained on the charts. The track may be transferred to a chart on the Mercator projection by plotting a number of its points by their coordinates and joining them with a curved line.

The navigator who contemplates the use of great circle tracks will find it of the greatest convenience to be provided with these gnomonic charts for the regions which his vessel is to traverse.

**190.** BY COMPUTATION.—This method consists in determining a series of points on the great circle by their coordinates of latitude and longitude, plotting them upon a Mercator chart, and tracing the curve that joins them. The first point determined is the *vertex*, or point of highest latitude, even when, as sometimes occurs, it falls without that portion of the great circle which joins the points of departure and destination.



FIG. 27.

In figure 27, A represents the point of departure; B, the point of destination; AVB, the great circle joining them, with its vertex at V; and P, the pole of the earth.
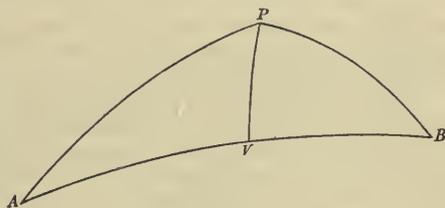
Let $C_A$ = PAB, the initial course;
$C_B$ = PBA, the final course;
$L_A$, $L_V$, $L_B$ = the latitudes of the respective points A, V, B = (90° − PA), (90° − PV), (90° − PB).
$Lo_{AB}$, $Lo_{AV}$, $Lo_{BV}$ = the differences of longitude between A and B, A and V, B and V, respectively, = APB, APV, BPV.
$D$ = the great circle distance between A and B; and
$\varphi$ = an auxiliary angle introduced for the computation.

We then have:

$$\tan \varphi = \cos Lo_{AB} \cot L_B;$$
$$\cot C_A = \cot Lo_{AB} \cos (L_A + \varphi) \operatorname{cosec} \varphi;$$
$$\cot D = \cos C_A \tan (L_A + \varphi);$$
$$\cos L_V = \sin C_A \cos L_A;$$
$$\cot Lo_{AV} = \tan C_A \sin L_A.$$

By these formulæ are determined the initial course and the total distance by great circle; also the latitude of the vertex and its longitude with respect to A. By interchanging the subscript letters $_A$ and $_B$ throughout, we should obtain the final course, and the longitude of the vertex with respect to B; also the same total distance and latitude of the vertex as before.

In performing this computation, strict regard must be had to the signs of the quantities. If the points of departure and destination are in different latitudes, the latitude of one of these points must be regarded as negative with respect to the other, and they must be marked with opposite signs. Should $Lo_{AV}$ or $Lo_{BV}$ assume a negative value, it indicates that the vertex does not lie between A and B, and is to be laid off accordingly.

To find other points of the great circle, M, N, etc., let their latitudes be represented by $L_M$, $L_N$, etc., and their longitudes from the vertex by $Lo_{VM}$, $Lo_{VN}$, etc.; then

$$\tan L_M = \tan L_V \cos Lo_{VM}; \text{ or, } \cos Lo_{VM} = \tan L_M \cot L_V;$$
$$\tan L_N = \tan L_V \cos Lo_{VN}; \text{ or, } \cos Lo_{VN} = \tan L_N \cot L_V;$$

and so on. By these formulæ intervals of longitude from the vertex of 5°, 10°, or any amount, may be assumed, and the corresponding latitudes deduced; or any latitude may be assumed and its corresponding interval of longitude from the vertex found. Two positions will result from each solution, and the appropriate ones may be chosen by keeping in mind the signs involved.

EXAMPLE: Given two places, one in Lat. 40° N., Long. 70° W., the other in Lat. 30° S., Long. 10° W., find the great circle distance between them; also the initial course, and the longitude of equator crossing.

$$L_A = +40°; \quad L_B = -30°; \quad Lo_{AB} = 60°.$$

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lo$_{AB}$ | 60° | cos | 9.69897 | cot | 9.76144 | | | |
| L$_B$ | − 30° | cot (−) | .23856 | | | | | |
| L$_A$ | + 40° | | | | | cos 9.88425 | sin | 9.80807 |
| $\varphi$ | − 40° 54′ | tan (−) 9.93753 | cosec(−) .18393 | | | | | |
| (L$_A$+$\varphi$) | − 0° 54′ | | cos | 9.99995 | tan (−) 8.19616 | | | |
| C$_A$ | 131° 24′ or S. 48°36′ E | cot | (−)9.94532 | cos (−) 9.82041 | sin 9.87513 | tan (−) .05472 | | |
| D | 89° 24′ or 5,364 miles | | cot | 8.01657 | | | | |
| L$_V$ | + 54° 56′ | | | | cos 9.75938 | | | |
| Lo$_{AV}$ | − 53° 54′ | | | | | cot (−)9.86279 | | |

The initial course is therefore S. 48° 36′ E., and the distance 5,364 nautical miles. (It may be found that the course by rhumb line is S. 38° 45′ E. and the distance 5,751 miles.) The vertex of the great circle is in Lat. 54° 56′ N., and is 53° 54′ in longitude from the point A, in a direction away from B; hence it is in Long. 123° 54′ W. To find the longitude of equator crossing let L$_M$ = 0°; then in the equation,

$$\cos Lo_{VM} = \tan L_M \cot L_V,$$

since tan L$_M$ equals zero, cos Lo$_{VM}$ also equals zero, or the longitude interval from the vertex is 90°, which is evident from the properties of the great circle; therefore the longitude of equator crossing is 123° 54′ W.—90°=33° 54′ W.

**191.** BY TIME AZIMUTH METHODS.—A convenient method of obtaining the initial and final courses in great circle sailing is afforded by the tables and graphic methods which are prepared for the solution of the *Time Azimuth* problem (art. 359, Chap. XIV). It will be found by comparison that if the latitude of the point of departure be substituted for the latitude of the observer in that problem, the latitude of destination for the declination of the celestial body, and the longitude interval for the hour angle; the solution for the initial course will coincide with that for the azimuth; by interchanging the latitudes of the points of departure and destination the final course will be similarly obtained. Advantage may thus be taken of the various methods provided for facilitating the determination of the azimuth to ascertain the great circle courses from one point to another.

**192.** BY GRAPHIC APPROXIMATIONS.—Of the numerous methods that fall within this class only two need be given.

**193.** By the use of a *Terrestrial Globe* the two given points between which the great circle track is required may be joined by the shortest line between them, either by means of a piece of thread or by moving the globe until they are brought to the fixed horizon which is usually provided; the coordinates of the various points of the track are then transferred to the chart. The number of minutes of arc, as measured on the scale of the horizon between the points, equals the number of miles of distance; if there be no horizon, the measure may be made by a thread along the equator or a meridian.

**194.** The *Method of Professor Airy* consists in drawing on the chart a rhumb line joining the two points, and erecting at its middle point a perpendicular; the following table should then be entered with the middle latitude as an argument, and the "corresponding parallel" of latitude taken out (noting whether it is the same or opposite in name to the middle latitude); where this parallel is intersected by the perpendicular that was drawn will be the center from which may be swept an arc approximately representing the great circle between the two points.

| Middle latitude. | Corresponding parallel. | Name. | Middle latitude. | Corresponding parallel. | Name. |
|---|---|---|---|---|---|
| ° | ° ′ | | ° | ° ′ | |
| 20 | 81 13 | Opposite. | 52 | 11 33 | Opposite. |
| 22 | 78 16 | Do. | 54 | 6 24 | Do. |
| 24 | 74 59 | Do. | 56 | 1 13 | Do. |
| 26 | 71 26 | Do. | 58 | 4 00 | Same. |
| 28 | 67 38 | Do. | 60 | 9 15 | Do. |
| 30 | 63 37 | Do. | 62 | 14 32 | Do. |
| 32 | 59 25 | Do. | 64 | 19 50 | Do. |
| 34 | 55 05 | Do. | 66 | 25 09 | Do. |
| 36 | 50 36 | Do. | 68 | 30 30 | Do. |
| 38 | 46 00 | Do. | 70 | 35 52 | Do. |
| 40 | 41 18 | Do. | 72 | 41 14 | Do. |
| 42 | 36 31 | Do. | 74 | 46 37 | Do. |
| 44 | 31 38 | Do. | 76 | 52 01 | Do. |
| 46 | 26 42 | Do. | 78 | 57 25 | Do. |
| 48 | 21 42 | Do. | 80 | 62 51 | Do. |
| 50 | 16 39 | Do. | | | |

## COMPOSITE SAILING.

**195.** It has already been stated that when, for any reason, it is impracticable or unadvisable to follow the great circle track to its highest latitude, a limiting parallel is chosen and the route modified accordingly. This method is denominated *Composite Sailing.*

**196.** The shortest track between points where a fixed latitude is not exceeded is made up as follows:

1. A great circle through the point of departure tangent to the limiting parallel.
2. A course along the parallel.
3. A great circle through the point of destination tangent to the limiting parallel.

The composite track may be determined by *Great Circle Sailing Chart*, by *Computation*, or by *Graphic Approximation*.

**197.** On a *Great Circle Sailing Chart*, draw lines from the points of departure and destination, respectively, tangent to the limiting parallel; transfer these great circles to a Mercator chart in the usual manner, by the coordinates of several points, including in each case the point of tangency to the parallel. Follow the first great circle to the parallel; then follow the parallel; then the second great circle. Determine great circle courses and distances from the gnomonic chart as thereon described; determine the distance along the parallel by Parallel Sailing.

**198.** *By computation,* the problem consists in finding the great circles which pass, respectively, through the points of departure and destination and have their vertices in the latitude of the limiting parallel. Resuming the designation of terms already employed (art. 190), we have:

$$\cos \text{Lo}_{VA} = \tan \text{L}_A \cot \text{L}_V ;$$
$$\cos \text{Lo}_{VB} = \tan \text{L}_B \cot \text{L}_V ;$$

where $\text{Lo}_{VA}$ and $\text{Lo}_{VB}$ represent the distances in longitude from A and from B to the respective points of tangency; other features of each of the great circles may be determined in the usual manner.

EXAMPLE: A vessel in Lat. 30° S., Long. 18° W., is bound to a point in Lat. 39° S., Long. 145° E., and it is decided not to go south of the parallel of 55° S. Find the longitude of reaching that parallel and the longitude at which it should be left.

$$\text{L}_A = 30° \text{ S.}; \quad \text{L}_B = 39° \text{ S.}; \quad \text{L}_V = 55° \text{ S.}$$
$$\text{Lo}_A = 18° \text{ W.}; \quad \text{Lo}_B = 145° \text{ E.}$$

| L$_A$ | 30° | tan 9.76144 | L$_B$ | 39° | tan 9.90837 |
|---|---|---|---|---|---|
| L$_V$ | 55° | cot 9.84523 | L$_V$ | 55° | cot 9.84523 |
| Lo$_{VA}$ | 66° 09′ E. | cos 9.60667 | Lo$_{VB}$ | 55° 27′ W. | cos 9.75360 |
| Lo$_A$ | 18 00 W. | | Lo$_B$ | 145 00 E. | |
| Lo$_V$ | 48 09 E. | | Lo$_V$ | 89 33 E. | |

**199.** A *graphic approximation* to the composite track may be obtained by drawing a straight line between the given points on a Mercator chart and erecting at its middle point a perpendicular, which should be extended until it intersects the limiting parallel. Then through this intersection and the two points describe the arc of a circle, and this will approximate to the shortest distance within the assigned limit of latitude.

**200.** A terrestrial globe may be employed for the determination of the composite track; the method of its use will suggest itself.

**201.** Another approximation is obtained by joining the two points with a single great circle, and following this to its intersection with the limiting parallel; thence sailing along the parallel until the great circle is again intersected; then resuming the circle and following it to the destination.

# CHAPTER VI.

## DEAD RECKONING.

**202.** *Dead Reckoning* is the process by which the position of a ship at any instant is found by applying to the last well-determined position the run that has since been made, using for the purpose the ship's course and the distance indicated by the log.

**203.** Positions by dead reckoning, also spoken of as positions *by account*, differ from those determined by bearings of terrestrial objects or by observations of celestial bodies in being less exact, as the correctness of dead reckoning depends upon the accuracy of the estimate of the run, and this is always liable to be at fault to a greater or less extent. The course made good by a ship may differ from that which it is believed that she is making good, by reason of imperfect steering, improper allowance for compass error and leeway, and the effects of unknown currents; the allowed distance over the ground may be in error on account of inaccurate logging and unknown currents.

Notwithstanding its recognized defects as compared with the more exact methods, the dead reckoning is an invaluable aid to the mariner. It affords him a means of plotting the position of the ship at any desired time between astronomical determinations; it also gives him an approximate position at the moment of taking astronomical observations which is a great convenience in working up those observations; and finally it affords the only available means of determining the location of a vessel at sea during those periods (which may continue for several days together) when the weather is such as to render the observation of celestial bodies an impossibility.

**204.** Taking Departure.—Before losing sight of the land, and preferably while objects remain in good view, it is the duty of the navigator to *take a departure;* this consists in fixing the position of the ship by the best means available (Chap. IV), and using this position as the origin for dead reckoning. There are two methods of reckoning the departure. The first and simpler consists in taking from the chart the latitude and longitude of the position found, and applying the future run thereto. The other requires that the bearing and distance of an object of known latitude and longitude be found; the position of the object then forms the basis of the reckoning, and the *reversed* direction of the bearing, with the distance, forms the first course and distance; thus it may be considered that the ship starts from the position of the object and sails to the position where the bearing was taken; the correction for deviation in such a case should be that due to the heading of the ship when the bearing was taken. Each time that a new position is determined it is used as a new departure for the dead reckoning.

This meaning of the term *departure* should not be confounded with the other, which refers to the distance run toward east or west.

**205.** Methods.—The working of dead reckoning merely involves an application of the methods of Traverse Sailing (art. 172) and Middle Latitude Sailing (art. 175), as explained in Chapter V.

The various compass courses are set down in a column, and abreast each are written the errors by reason of which the course steered by compass differs from the true course made good over the ground; thence the true course made good is determined and recorded; next, the distance is written in, and afterwards, by means of Tables 1 or 2 (according as the courses are expressed in quarter points or degrees), the difference of latitude and departure are found, separate columns being kept for distances to the north, south, east, and west.

When the position of the ship at any moment is required, add up all the differences of latitude and departure, and write in the column of the greater the difference between the northing and southing, and the easting and westing. Apply the difference of latitude to the latitude of the last determined position, which will give the latitude by D. R., and from which may be found the middle latitude; with the middle latitude find the difference of longitude corresponding to the departure, apply this to the longitude of last position, and the result will be the longitude by D. R.

The employment of the tabular form will be found to facilitate the work and guard against errors. It will be a convenience to include in that form columns showing the hour, together with the reading of the patent log (if used) each time that the course is changed or the dead reckoning worked up.

The employment of minutes and tenths in dead reckoning rather than minutes and seconds is recommended.

Example: A vessel under sail heading NE. $\frac{3}{4}$ E. (on which course deviation is $\frac{1}{4}$ pt, Easterly) takes departure from Cape Henry light-house (see Appendix IV for position), bearing SSW. $\frac{1}{2}$ W. per compass, distant 1.4 miles. She then sails on a series of courses, with errors and distances as indicated below; wind about SE. by E. Required the position by dead reckoning; also the course and distance made good by dead recokning.

| Comp. course. | Var. | Dev. | Leeway. | Error. | True course. | Dist. | N. | S. | E. | W. | D. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NNE. ½ E. | ½ W. | ¼ E. | | ¼ W. | NNE. ¼ E. | 1.4 | 1.3 | | 0.6 | | |
| NE. ¾ E. | ½ W. | ¼ E. | ¼ W. | ½ W. | NE. ¼ E. | 27.6 | 18.5 | | 20.5 | | |
| S. by W. | ½ W. | 0 | ¼ E. | ¼ W. | S. ¾ W. | 31.5 | | 31.2 | | 4.6 | |
| ENE. | ½ W. | ¼ E. | ½ W. | ¾ W. | NE. by E. ¼ E. | 14.2 | 7.3 | | 12.2 | | |
| S. ¼ E. | ½ W. | 0 | ½ E. | 0 | S. ¼ E. | 11.0 | | 11.0 | 0.5 | | |
| NE. ¼ N. | ¾ W. | ¼ E. | ¼ W. | ¾ W. | NE. by N. | 87.0 | 72.3 | | 48.3 | | |
| | | | | | | | 99.4 | 42.2 | 82.1 | 4.6 | |
| Made good, | | | | | NE. ¾ E. | 96.5 | 57.2 | | 77.5 | | 97.0 |

|  | *Latitude.* |  | *Longitude.* |
|---|---|---|---|
| Point of departure, | 36° 55′.6 N. | | 76° 00′.5 W. |
| Run, | 57 .2 N. | Mid. L., 37° | 1 37 .0 E. |
| By D. R. | 37 52 .8 N. | | 74 23 .5 W. |

EXAMPLE: A steamer's position by observation at noon, patent log reading 27.3, is Lat. 49° 15′ N., Long. 7° 32′ W. Thence she steers S. 82° W. (per compass), the total compass error on that course being 20° W., until 12.30, at which time, patent log reading 33.9, the course is changed to S. 80° W. (*p. c.*), same error. At 4.12, patent log 80.5, sights are taken from which it is found that the true longitude is 8° 46′ W., and the compass error 19° W. At 6.15, patent log reading 6.1, a sight is taken from which it is found that the true latitude is 48° 34′ 30″ N. At 8 p. m. the patent log reads 27.5. Required the positions by D. R. at each sight and at 8 o'clock.

| Time. | Comp. course. | Error. | True course. | Pat. Log. | Dist. | S. | W. | D. |
|---|---|---|---|---|---|---|---|---|
| Noon. | | | | 27.3 | | | | |
| 12.30 | S. 82° W. | 20° W. | S. 62° W. | 33.9 | 6.6 | 3.1 | 5.8 | |
| 4.12 | S. 80° W. | 20° W. | S. 60° W. | 80.5 | 46.6 | 23.3 | 40.3 | |
| | | | | | | 26.4 | 46.1 | 70.3 |
| 6.15 | S. 86° W. | 19° W. | S. 61° W. | 6.1 | 25.6 | 12.4 | 22.4 | 34.1 |
| 8.00 | S. 86° W. | 19° W. | S. 61° W. | 27.5 | 21.4 | 10.4 | 18.7 | 27.9 |

|  | *Latitude.* |  | *Longitude.* |
|---|---|---|---|
| By obs. at noon, | 49° 15′.0 N. | | 7° 32′.0 W. |
| Run to 4.12 sight, | 26.4 S. | Mid. L., 49° | 1 10.3 W. |
| By D. R. at 4.12 sight, | 48 48.6 N. | | 8 42.3 W. |
| By obs. at 4.12 sight, | | | 8 46.0 W. |
| Run to 6.15 sight, | 12.4 S. | Mid. L., 49° | 34.1 W. |
| By D. R. at 6.15 sight, | 48 36.2 N. | | 9 20.1 W. |
| By obs. at 6.15 sight, | 48 34.5 N. | | |
| Run to 8 p. m., | 10.4 S. | Mid. L., 48° | 27.9 W. |
| By D. R. at 8 p. m., | 48 24.1 N. | | 9 48.0 W. |

**206.** ALLOWANCE FOR CURRENT.—When a vessel is sailing in a known current whose strength may be estimated with a fair degree of accuracy, a more correct position may be arrived at by regarding the set and drift of the current as a course and distance to be regularly taken account of in the dead reckoning.

EXAMPLE: A vessel in the Gulf Stream at a point where the current is estimated to set N. 48° E. at the rate of 1.8 miles an hour, sails S. 3° W. (true), making 9.5 knots an hour through the water for 3ʰ 30ᵐ. Middle latitude 35°. Required the course and distance made good.

| | True course. | Dist. | N. | S. | E. | W. | D. |
|---|---|---|---|---|---|---|---|
| Run | S. 3° W. | 33.3 | | 33.3 | | 1.7 | |
| Current | N. 48° E. | 6.3 | 4.2 | | 4.7 | | |
| Made good | S. 6° E. | 29.3 | | 29.1 | 3.0 | | 3.6 |

**207.** FINDING THE CURRENT.—It is usual, upon obtaining a good position by observation (as the navigator usually does at noon), to compare that position with the one obtained by dead reckoning, and to attribute such discrepancy as may be found to the effects of current. It has already been pointed out that other causes than the motion of the water tend to make the dead reckoning inaccurate, so that it must not be assumed that currents proper are thus determined with complete correctness.

Current is said to have *set* and *drift*, referring respectively to the direction toward which it is flowing and the velocity with which it moves.

It is evident that, in calculating current by the method of comparing positions by observation with those by account, the navigator must limit himself to the periods during which the dead reckoning has been brought forward independently, without receiving any corrections due to new points of departure. In case it is desired to find the current covering a period during which fresh departures have been used, as from noon to noon, find the algebraical sums of all the differences of latitude and longitude from the table, and apply these to the latitude and longitude of original departure—that of the preceding noon; this gives the position from the ship's run proper, and the difference between this and the position by observation gives the set and drift for the twenty-four hours; if an allowance has been made for current, as explained in the preceding article, that must be omitted in bringing up the position which is to take account of the run only.

**208.** DAY'S RUN.—It is usual to calculate, each day at noon, the ship's total run for the preceding twenty-four hours. Having the positions at noon of each day, the course and distance between them is found as explained in article 175, Chapter V. The position by observation is used in each case, if such has been found; otherwise, the position by dead reckoning.

EXAMPLE: At noon, January 22, the position of a vessel by observation was Lat. 35° 10′ N., Long. 134° 01′ W. During the next 24 hours, the run by account was 60.1 miles north and 153.2 miles east. At noon, January 23, the position by observation was Lat. 36° 03′ N., Long. 131° 14′ W. Required the position by D. R. at the latter time; also the run and current for the 24 hours.

|  | *Latitude.* |  | *Longitude.* |
|---|---|---|---|
| By obs., noon, 22d, | 35° 10′.0 N. | Mid. L., 36° | 134° 01′.0 W. |
| Run, | 1   00 .1 N. | Dep., 153.2 E. | 3   09 .4 E. |
| By D. R., noon, 23d, | 36   10 .1 N. | D, 189.4 E. | 130   51 .6 W. |
| By obs., noon, 23d, | 36   03 .0 N. | D,   22.4 W. | 131   14 .0 W. |
| Current, | 6 .9 S. | Dep., 18.1 W. | 22 .4 W. |

Current for 24 hours, 6.9 S., 18.1 W. = S. 69° W., 19.4 miles.
Current per hour, S. 69° W., 0.8 mile.

|  | *Latitude.* |  | *Longitude.* |
|---|---|---|---|
| By obs., noon, 23d, | 36° 03′,0 N. | Mid. L., 36° | 131° 14′.0 W. |
| By obs., noon, 22d, | 35   10 .0 N. | D,   167.0 E. | 134   01 .0 W. |
| Run, | 0   53 .0 N. | Dep., 135.1 | 2   47 .0 E. |

Run for 24 hours, 53.0 N., 135.1 E. = N. 68° E., 146 miles.

## CHAPTER VII.

## DEFINITIONS RELATING TO NAUTICAL ASTRONOMY.

**209.** *Nautical Astronomy,* or *Celo-Navigation,* has been defined (art. 3, Chap. I) as that branch of the science of Navigation in which the position of a ship is determined by the aid of celestial objects—the sun, moon, planets, or stars.

**210.** The Celestial Sphere.—An observer upon the surface of the earth appears to view the heavenly bodies as if they were situated upon the surface of a vast hollow sphere, of which his eye is the center. In reality we know that this apparent vault has no existence, and that we can determine only the relative directions of the heavenly bodies—not their distances from each other or from the observer. But by adopting an imaginary spherical surface of an infinite radius, the eye of the observer being at the center, the places of the heavenly bodies can be projected upon this *Celestial Sphere,* or *Celestial Concave,* at points where the lines joining them with the center intersect the surface of the sphere. Since, however, the center of the earth should be the point from which all angular distances are measured, the observer, by transferring himself there, will find projected on the celestial sphere, not only the heavenly bodies, but the imaginary points and circles of the earth's surface. The actual position of the observer on the surface will be projected in a point called the *zenith;* the meridians, equator, and all other lines and points may also be projected.

**211.** An observer on the earth's surface is constantly changing his position with relation to the celestial bodies projected on the sphere, thus giving to the latter an apparent motion. This is due to three causes: first, the diurnal motion of the earth, arising from its rotation upon its axis; second, the annual motion of the earth, arising from its motion about the sun in its orbit; and third, the actual motion of certain of the celestial bodies themselves. The changes produced by the diurnal motion are different for observers at different points upon the earth, and therefore depend upon the latitude and longitude of the observer. But the changes arising from the other causes named are independent of the observer's position, and may therefore be considered at any instant in their relation to the center of the earth. To this end the elements necessary for any calculation are tabulated in the *Nautical Almanac* from data based upon laws which have been found by long series of observations to govern the actual and apparent motion of the various bodies.

**212.** The *Zenith* of an observer on the earth's surface is the point of the celestial sphere vertically overhead. The *Nadir* is the point vertically beneath.

**213.** The *Celestial Horizon* is the great circle of the celestial sphere formed by passing a plane through the center of the earth at right angles to the line which joins that point with the zenith of the observer. The celestial horizon differs somewhat from the *Visible Horizon,* which is that line appearing to an observer at sea to mark the intersection of earth and sky. This difference arises from two causes: first, the eye of the observer is always elevated above the sea level, thus permitting him a range of vision exceeding 90° from the zenith; and second, the observer's position is on the surface, instead of at the center of the earth. These causes give rise, respectively, to *dip of the horizon* and *parallax,* which will be explained later (Chap. X).

**214.** In figure 28 the celestial sphere is considered to be projected upon the celestial horizon, represented by NESW.; the zenith of the observer is projected at Z, and that pole of the earth which is elevated above the horizon, assumed for illustration to be the north pole, appears at P, the *Elevated Pole* of the celestial sphere. The other pole is not shown in the figure.

**215.** The *Equinoctial,* or *Celestial Equator,* is the great circle formed by extending the plane of the earth's equator until it intersects the celestial sphere. It is shown in the figure in the line EQW. The equinoctial intersects the horizon in E and W, its east and west points.



FIG. 28.

**216.** *Hour Circles, Declination Circles,* or *Celestial Meridians* are great circles of the celestial sphere passing through the poles; they are therefore secondary to the equinoctial, and may be formed by extending the planes of the respective terrestrial meridians until they intersect the celestial sphere. In the figure, PW, PS, PE, are hour circles, and that one, PS, which contains the zenith and is therefore formed by the extension of the terrestrial meridian of the observer, intersects the horizon in N and S, its north and south points.

**217.** *Vertical Circles,* or *Circles of Altitude,* are great circles of the celestial sphere which pass through the zenith and nadir; they are therefore secondary to the horizon. In the figure, ZH, WZE, NZS, are projections of such circles; the vertical circle NZS, which passes through the poles, coincides with the
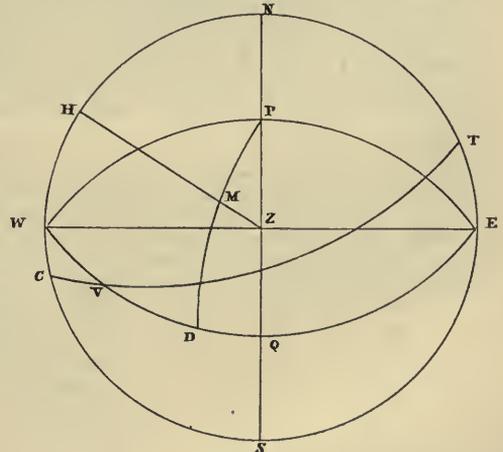
meridian of the observer. The vertical circle WZE, whose plane is at right angles to that of the meridian, intersects the horizon in its eastern and western points, and, therefore, at the points of intersection of the equinoctial; this circle is distinguished as the *Prime Vertical*.

**218.** The *Declination* of any point in the celestial sphere is its angular distance from the equinoctial, measured upon the hour or declination circle which passes through that point; it is designated as *North* or *South* according to the direction of the point from the equinoctial; it is customary to regard north declinations as positive (+), and south declinations as negative (−). In the figure, DM is the declination of the point M. Declination upon the celestial sphere corresponds with latitude upon the earth.

**219.** The *Polar Distance* of any point is its angular distance from the pole (generally, the elevated pole of an observer), measured upon the hour or declination circle passing through the point; it must therefore equal 90° *minus* the declination, if measured from the pole of the same name as the declination, or 90° *plus* the declination, if measured from the pole of opposite name. The polar distance of the point M from the elevated pole, P, is PM.

**220.** The *Altitude* of any point in the celestial sphere is its angular distance from the horizon, measured upon the vertical circle passing through the point; it is regarded as positive when the body is on the same side of the horizon as the zenith. The altitude of the point M is HM.

**221.** The *Zenith Distance* of any point is its angular distance from the zenith, measured upon the vertical circle passing through the point; the zenith distance of any point which is above the horizon of an observer must therefore equal 90° *minus* the altitude. The zenith distance of M, in the figure, is ZM.

**222.** The *Hour Angle* of any point is the angle at the pole between the meridian of the observer and the hour circle passing through that point; it may also be regarded as the arc of the equinoctial intercepted between those circles. It is measured toward the west as a positive direction through the twenty-four hours, or 360 degrees, which constitute the interval between the successive returns to the meridian, due to the diurnal rotation of the earth, of any point in the celestial sphere. The hour angle of M is the angle QPD, or the arc QD.

**223.** The *Azimuth* of a point in the celestial sphere is the angle at the zenith between the meridian of the observer and the vertical circle passing through the point; it may also be regarded as the arc of the horizon intercepted between those circles. It is measured from either the north or the south point of the horizon (usually that one of the same name as the elevated pole) to the east or west through 180°, and is named accordingly; as, N. 60° W., or S. 120° W. The azimuth of M is the angle NZH, or the arc NH, from the north point, or the angle SZH, or the arc SH, from the south point of the horizon.

**224.** The *Amplitude* of a point is the angle at the zenith between the prime vertical and the vertical circle of the point; it is measured from the east or the west point of the horizon through 90°, as W. 30° N. It is closely allied with the azimuth and may always be deduced therefrom. In the figure, the amplitude of H is the angle WZH, or the arc WH. The amplitude is only used with reference to points in the horizon.

**225.** The *Ecliptic* is the great circle representing the path in which, by reason of the annual revolution of the earth, the sun appears to move in the celestial sphere; the plane of the ecliptic is inclined to that of the equinoctial at an angle of 23° 27½′, and this inclination is called the *obliquity of the ecliptic*. The ecliptic is represented by the great circle CVT.

**226.** The *Equinoxes* are those points at which the ecliptic and the equinoctial intersect, and when the sun occupies either of these positions the days and nights are of equal length throughout the earth. The *Vernal Equinox* is that one at which the sun appears to an observer on the earth when passing from southern to northern declination, and the *Autumnal Equinox* that one at which it appears when passing from northern to southern declination. The Vernal Equinox is also designated as the *First Point of Aries*, and is used as an origin for reckoning right ascension; it is indicated in the figure at V.

**227.** The *Solstitial Points*, or *Solstices*, are points of the ecliptic at a distance of 90° from the equinoxes, at which the sun attains its highest declination in each hemisphere. They are called respectively the *Summer* and the *Winter Solstice*, according to the season in which the sun appears to pass these points in its path.

**228.** The *Right Ascension* of a point is the angle at the pole between the hour circle of the point and that of the First Point of Aries; it may also be regarded as the arc of the equinoctial intercepted between those circles. It is measured from the First Point of Aries to the eastward as a positive direction, through twenty-four hours or 360 degrees. The right ascension of the point M is VD.

**229.** *Celestial Latitude* is measured to the north or south of the ecliptic upon great circles secondary thereto. *Celestial Longitude* is measured upon the ecliptic from the First Point of Aries as an origin, being regarded as positive to the eastward throughout 360°.

**230.** COORDINATES.—In order to define the position of a point in space, a system of lines, angles, or planes, or a combination of these, is used to refer it to some fixed line or plane adopted as the primitive; and the lines, angles, or planes by which it is thus referred are called *coordinates*.



FIG. 29.

**231.** In figure 29 is shown a system of rectilinear coordinates for a plane. A fixed line FE is chosen, and in it a definite point C, as the *origin*. Then the position of a point A is defined by CB = *x*, the distance from the origin, C, to the foot of a perpendicular let fall from A on FE; and by AB = *y*, the length of the perpendicular. The distance *x* is called the *abscissa* and *y* the *ordinate*. Assuming two intersecting right lines FE and HI as standard lines of reference, the location of the point A is defined by regarding the distances measured to the right hand of HI and above FE as *positive;* those to the left hand of HI and below FE as *negative.*

An exemplification of this system is found in the chart, on which FE is represented by the equator, HI by the prime meridian; the coordinates *x* and *y* being the longitude and latitude of the point A.
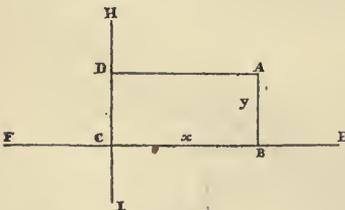
**232.** The great circle is to the sphere what the straight line is to the plane; hence, in order to define the position of a point on the surface of a sphere, some great circle must be selected as the primary, and some particular point of it as the origin. Thus, in figure 30, which represents the case of a sphere, some fixed great circle, CBQ, is selected as the axis and called the *primary;* and a point C is chosen as the origin. Then to define the position of any point A, the abscissa *x* equals the distance from C to the point B, where the secondary great circle through A intersects the primary; the ordinate *y* equals the distance of A from the primary measured on the secondary—that is, *x* = CB and *y* = AB.



**233.** In the case of the earth, the primary selected is the equator (its plane being perpendicular to the earth's axis), and upon this are measured the abscissæ, while upon the secondaries to it are measured the ordinates of all points on the earth's surface. The initial point for reference on the equator is determined by the *prime meridian* chosen, West longitudes and North latitudes being called *positive,* East longitudes and South latitudes, *negative.*

**234.** In the case of the celestial sphere, there are four systems of coordinates in use for defining the position of any point; these vary according to the circle adopted as the primary and the point used as an origin. They are as follows:

1. Altitude and azimuth.
2. Declination and hour angle.
3. Declination and right ascension.
4. Celestial latitude and longitude.

**235.** In the system of *Altitude and Azimuth,* the primary circle is the celestial horizon, the secondaries to which are the vertical circles, or circles of altitude. The horizon is intersected by the celestial meridian in its northern and southern points, of which one—usually that adjacent to the elevated pole—is selected as an origin for reckoning coordinates. The azimuth indicates in which vertical circle the point to be defined is found, and the altitude gives the position of the point in that circle. In figure 28 the point M is located, according to this system, by its azimuth NH and altitude HM.

**236.** In the system of *Declination and Hour Angle,* the primary circle is the equinoctial, the secondaries to which are the circles of declination, or hour circles. The point of origin is that point of intersection of the equinoctial and celestial meridian which is above the horizon. The hour angle indicates in which declination circle the point to be defined is found, and the declination gives the position of the point in that circle. In figure 28 the point M is located, according to this system, by its hour angle QD and declination DM.

**237.** In the system of *Declination and Right Ascension,* the primary and secondaries are the same as in the system just described, but the point of origin differs, being assumed to be at the First Point of Aries, or vernal equinox. The right ascension indicates in which declination circle the point to be defined may be found, and the declination gives the position in that circle. In figure 28 the point M is located by VD, the right ascension, and DM, the declination. It should be noted that this system differs from the preceding in that the position of a point is herein referred to a fixed point in the celestial sphere and is independent of the zenith of the observer as well as of the position of the earth in its diurnal motion, while, in the system of declination and hour angle, both of these are factors in determining the coordinates.

**238.** In the system of *Celestial Latitude and Longitude,* the primary circle is the ecliptic; the point of origin, the First Point of Aries. The method of reckoning by this system, which is of only slight importance in Nautical Astronomy, will appear from the definitions of celestial latitude and longitude already given (art. 229).
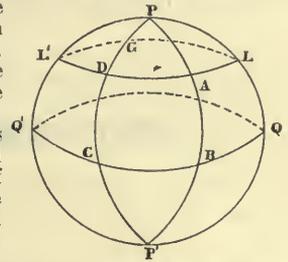
# CHAPTER VIII.

# INSTRUMENTS EMPLOYED IN NAUTICAL ASTRONOMY.

### THE SEXTANT.

**239.** The *sextant* is an instrument for measuring the angle between two objects by bringing into coincidence at the eye of the observer rays of light received directly from the one and by reflection from the other, the measure being afforded by the inclination of the reflecting surfaces. By reason of its small dimensions, its accuracy, and, above all, the fact that it does not require a permanent or a stable mounting but is available for use under the conditions existing on shipboard, it is a most important instrument for the purposes of the navigator. While the sextant is not capable of the same degree of accuracy as fixed instruments, its measurements are sufficiently exact for navigation.

**240.** DESCRIPTION.—A usual form of the sextant is represented in figure 31. The frame is of brass or some similar alloy. The graduated arc, AA, generally of silver, is marked in appropriate divisions; in the finer sextants, each division represents 10′, and the vernier affords a means of reading to 10″. A wooden handle, H, is provided for holding the instrument. The *index mirror*, M, and *horizon mirror*, m, are of plate glass, and are silvered, though the upper half of the horizon glass is left plain to allow direct rays to pass through unobstructed. To give greater distinctness to the images, a small *telescope*, E, is placed in the line of sight; it is supported in a ring, K, which can be moved by a screw in a direction at right angles to the plane of the sextant, thus shifting the axis of the telescope, and therefore the plane of reflection; this plane, however, always remains parallel to that of the instrument, the motion of the telescope being intended merely to regulate the relative brightness of the direct and reflected images. In the ring K are small screws for the purpose of adjusting the telescope by making its axis parallel with the plane of the sextant. The vernier is carried on the end of an index bar pivoted beneath the index mirror, M, and thus travels along the graduated scale, affording a measure for any change of inclination of the index mirror; a reading glass, R, attached to the index bar and turning upon a pivot, S, facilitates the reading of vernier and scale. The index mirror, M, is attached to the head of the index bar, with its surface perpendicular to the plane of the instrument; an adjusting screw is fitted at the back to permit of adjustment to the perpendicular plane. The fixed glass m, half silvered and half plain, is called the *horizon glass*, as it is through this that the horizon is observed in measuring altitudes of celestial bodies; it is provided with screws, by which its perpendicularity to the plane of the instrument may be adjusted. At P and Q are colored glasses of different shades, which may be used separately or in combination to protect the eye from the intense light of the sun. In order to observe with accuracy and make the images come precisely into contact, a *tangent-screw*, B, is fixed to the index, by means of which the latter may be moved with greater precision than by hand; but this screw does not act until the index is fixed by the screw C at the back of the sextant; when the index is to be moved any considerable amount, the screw C is loosened; when it is brought near to its required position the screw must be tightened, and the index may then be moved gradually by the tangent-screw.

Besides the telescope, E, the instrument is usually provided with an inverting telescope, I, and a tube without glasses, F; also, with a cap carrying colored glasses, which may be put on the eye-end of the telescope, thus dispensing with the necessity for the use of the colored shades, P and Q, and eliminating any possible errors which might arise from nonparallelism of their surfaces.

**241.** The *vernier* is an attachment for facilitating the exact reading of the scale of a sextant, by which aliquot parts of the smallest divisions of the graduated scale are measured. The principle of the sextant vernier is identical with that of the barometer vernier, a complete description of which will be found in article 51, Chapter II. The arc of a sextant is usually divided into 120 or more parts, each

FIG. 31.

division representing 1°; each of these degree divisions is further subdivided to an extent dependent upon the accuracy of reading of which the sextant is capable. In the instruments for finer work, the divisions of the scale correspond to 10′ each, and the vernier covers a length corresponding to 59 such divisions, which is subdivided into 60 parts, thus permitting a reading of 10″; all sextants, however, are not so closely graduated.

Whatever the limits of subdivision, all sextants are fitted with verniers which contain one more division than the length of scale covered, and in which, therefore, scale-readings and vernier-readings increase in the same direction—toward the left hand. To read any sextant, it is merely necessary to observe the scale division next below, or to the right of, the zero of the vernier, and to add thereto the angle corresponding to that division of the vernier scale which is most nearly in exact coincidence with a division of the instrument scale.

**242.** OPTICAL PRINCIPLE.—When a ray of light is reflected from a plane surface, the angle of incidence is equal to the angle of reflection. From this it may be proved that when a ray of light undergoes two reflections in the same plane the angle between its first and its last direction is equal to twice the inclination of the reflecting surfaces. Upon this fact the construction of the sextant is based.

In figure 32 let B and C represent respectively the index mirror and horizon mirror of a sextant; draw EF perpendicular to B, and CF perpendicular to C; then the angle CFB represents the inclination of the two mirrors. Suppose a ray to proceed from A and undergo reflection at B and at C, its last direction being CD; then ADC is the angle between its first and last directions, and we desire to prove that ADC = 2 CFB.

From the equality of the angles of incidence and reflection:



FIG. 32.

$$ABE = EBC, \text{ and } ABC = 2\ EBC;$$
$$BCF = FCD, \text{ and } BCD = 2\ BCF.$$

From Geometry:

$$ADC = ABC - BCD = 2\ (EBC - BCF) = 2\ CFB,$$

which is the relation that was to be proved.

**243.** In the sextant, since the index mirror is immovably attached to the index arm, which also carries the vernier, it follows that no change can occur in the inclination between the index mirror and the horizon mirror, excepting such as is registered by the travel of the vernier upon the scale.

If, when the index mirror is so placed that it is nearly parallel with the horizon mirror, an observer direct the telescope toward some well-defined object, there will be seen in the field of view two separate images of the object; and if the inclination of the index mirror be slightly changed by moving the index bar, it will be seen that while one of the images remains fixed the other moves. The fixed image is the direct one seen through the unsilvered part of the horizon glass, while the movable image is due to rays reflected by the index and horizon mirrors. When the two images coincide these mirrors must be parallel (assuming that the object is sufficiently distant to disregard the space which separates the mirrors); in this position of the index mirror the vernier indicates the true zero of the scale. If, however, instead of observing a single object, the instrument is so placed that the direct ray from one object appears in coincidence with the reflected ray of a second object, then the true angle between the objects will be twice the angle of inclination between the mirrors, or twice the angle measured by the vernier from the true zero of the scale. To avoid the necessity of doubling the angle on the scale, the latter is so marked that each half degree appears as a whole degree, whence its indications give the whole angle directly.

**244.** ADJUSTMENTS OF THE SEXTANT.—The theory of the sextant requires that, for accurate indications, the following conditions be fulfilled:

(*a*) The two surfaces of each mirror and shade glass must be parallel planes.

(*b*) The graduated arc or limb must be a plane, and its graduations, as well as those of the vernier, must be exact.

(*c*) The axis must be at the center of the limb, and perpendicular to the plane thereof.

(*d*) The index and horizon glasses must be perpendicular, and the line of sight parallel, to the plane of the limb.

Of these, only the last named ordinarily require the attention of the navigator who is to make use of the sextant; the others, which may be called the *permanent adjustments*, should be made before the instrument leaves the hands of the maker, and with careful use will never be deranged.

**245.** The *Adjustment of the Index Mirror* consists in making the reflecting surface of this mirror truly perpendicular to the plane of the sextant. In order to test this, set the index near the middle of the arc, then, placing the eye very nearly in the plane of the sextant and close to the index mirror, observe whether the direct image of the arc and its image reflected from the mirror appear to form one continuous arc; if so, the glass is perpendicular to the plane of the sextant; if the reflected image appears to droop from the arc seen directly, the glass leans backward; if it seems to rise, the glass leans forward. The adjustment is made by the screws at the back of the mirror.

**246.** The *Adjustment of the Horizon Mirror* consists in making the reflecting surface of this mirror perpendicular to the plane of the sextant. The index mirror having been adjusted, if, in revolving it by means of the index arm, there is found one position in which it is parallel to the horizon glass, then the latter must also be perpendicular to the plane of the sextant. In order to test this, put in the telescope and direct it toward a star; move the index until the reflected image appears to pass the direct image; if one passes directly over the other the mirrors must be parallel; if one passes on either side of the other the horizon glass needs adjustment, which is accomplished by means of the screws attached.
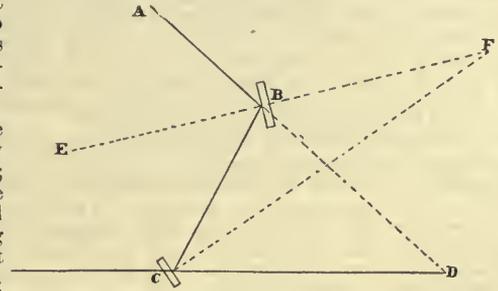
The sea horizon may also be used for making this adjustment. Hold the sextant vertically and bring the direct and the reflected images of the horizon line into coincidence; then incline the sextant until its plane makes but a small angle with the horizon; if the images still coincide the glasses are parallel; if not, the horizon glass needs adjustment.

**247.** The *Adjustment of the Telescope* must be so made that, in measuring angular distances, the line of sight, or axis of the telescope, shall be parallel to the plane of the instrument, as a deviation in that respect, in measuring large angles, will occasion a considerable error. To avoid such error, a telescope is employed in which are placed two wires, parallel to each other and equidistant from the center of the telescope; by means of these wires the adjustment may be made. Screw on the telescope, and turn the tube containing the eyeglass till the wires are parallel to the plane of the instrument; then select two clearly-defined objects whose angular distance must be not less than 90°, because an error is more easily discovered when the distance is great; bring the reflected image of one object into exact coincidence with the direct image of the other at the inner wire; then, by altering slightly the position of the instrument, make the objects appear on the other wire; if the contact still remains perfect, the axis of the telescope is in its right situation; but if the two objects appear to separate or lap over at the outer wire the telescope is not parallel, and it must be rectified by turning one of the two screws of the ring into which the telescope is screwed, having previously unturned the other screw; by repeating this operation a few times the contact will be precisely the same at both wires, and the axis of the telescope will be parallel to the plane of the instrument.

Another method of making this adjustment is to place the sextant upon a table in a horizontal position, look along the plane of the limb, and make a mark upon a wall, or other vertical surface, at a distance of about 20 feet; draw another mark above the first at a distance equal to the height of the axis of the telescope above the plane of the limb; then so adjust the telescope that the upper mark, as viewed through the telescope, falls midway between the wires. Some sextants are accompanied by small sights whose height is exactly equal to the distance between the telescope and the plane of the limb; by the use of these, the necessity for employing the second mark is avoided and the adjustment can be very accurately made.

**248.** The errors which arise from defects in what have been denominated the *permanent adjustments* of the sextant may be divided into three classes, namely: Errors due to faulty centering of the axis, called *eccentricity;* errors of graduation; and errors arising from lack of parallelism of surfaces in index mirror and in shade glasses.

The errors due to eccentricity and faulty graduation are constant for the same angle, and should be determined once for all at some place where proper facilities for doing the work are at hand; these errors can only be ascertained by measuring known angles with the sextant. If angles of 10°, 20°, 30°, 40°, etc., are first laid off with a theodolite or similar instrument and then measured by the sextant, a table of errors of the sextant due to eccentricity and faulty graduation may be made, and the error at any intermediate angle found by interpolation; this table will include the error of graduation of the theodolite and also the error due to inaccurate reading of the sextant, but such errors are small. Another method for determining the combined errors of eccentricity and graduation is by measuring the angular distance between stars and comparing the observed and the computed arc between them, but this process is liable to inaccuracies by reason of the uncertainty of allowances for atmospheric refraction.

Errors of graduation, when large, may be detected by "stepping off" distances on the graduated arc with the vernier; place the zero of the vernier in exact coincidence with a division of the arc, and observe whether the final division of the vernier also coincides with a division of the arc; this should be tried at numerous positions of the graduated limb, and the agreement ought to be perfect in every case.

The error due to a prismatic index mirror may be found by measuring a certain unchangeable angle, then taking out the glass and turning the upper edge down, and measuring the angle again; half the difference of these two measures will be the error at that angle due to the mirror. From a number of measures of angles in this manner, a table similar to the one for eccentricity and faulty graduation can be made; or the two tables may be combined. When possible to avoid it, however, no sextant should be used in which there is an index mirror which produces a greater error than that due to the probable error of reading the scale. Mirrors having a greater angle than 2″ between their faces are rejected for use in the United States Navy. Index mirrors may be roughly tested by noting if there is an elongated image of a well-defined point at large angles.

Since the error due to a prismatic horizon mirror is included in the index correction (art. 249), and consequently applied alike to all angles, it may be neglected.

Errors due to prismatic shade glasses can be determined by measuring angles with and without the shade glasses and noting the difference. They may also be determined, where the glasses are so arranged that they can be turned through an angle of 180°, by measuring the angle first with the glass in its usual position and then reversed, and taking the mean of the two as the true measure.

**249.** Index Error.—The *Index Error* of a sextant is the error of its indications due to the fact that when the index and horizon mirrors are parallel the zero of the vernier does not coincide with the zero of the scale. Having made the adjustments of the index and horizon mirrors and of the telescope, as previously described, it is necessary to find that point of the arc at which the zero of the vernier falls when the two mirrors are parallel, for all angles measured by the sextant are reckoned from that point. If this point is to the left of the zero of the limb, all readings will be too great; if to the right of the zero, all readings will be too small.

If desirable that the reading should be zero when the mirrors are parallel, place the zero of the vernier on zero of the arc; then, by means of the adjusting screws of the horizon glass, move that glass until the direct and reflected images of the same object coincide, after which the perpendicularity of the horizon glass should again be verified, as it may have been deranged by the operation. This adjustment is not essential, since the correction may readily be determined and applied to the reading. In certain sextant work, however, such as surveying, it will be very convenient to be relieved of the

necessity of correcting each angle observed. The sextant should never be relied upon for maintaining a constant index correction, and the error should be ascertained frequently. It is a good practice to verify the correction each time a sight is taken.

**250.** The *Index Correction* may be found (*a*) by a star, (*b*) by the sea horizon, and (*c*) by the sun.

(*a*) Bring the direct and reflected images of a star into coincidence, and read off the arc. The index correction is numerically equal to this reading, and is positive or negative according as the reading is on the right or left of the zero.

(*b*) The same method may be employed, substituting for a star the sea horizon, though this will be found somewhat less accurate.

(*c*) Measure the apparent diameter of the sun by first bringing the upper limb of the reflected image to touch the lower limb of the direct image, and then bringing the lower limb of the reflected image to touch the upper limb of the direct image.

Denote the readings in the two cases by $r$ and $r'$; then, if S = apparent diameter of the sun, and R = the reading of the sextant when the two images are in coincidence, we have:

$$r = R + S,$$
$$r' = R - S,$$
$$R = \tfrac{1}{2}(r + r').$$

As R represents the *error*, the *correction* will be − R. Hence the rule: Mark the readings when *on* the arc with the *negative* sign; when *off*, with the *positive* sign; then the index correction is one-half the algebraic sum of the two readings.

EXAMPLE: The sun's diameter is measured for index correction as follows: On the arc, 31′ 20″; off the arc, 33′ 10″. Required the correction.

$$
\begin{array}{lr}
\text{On the arc,} & -31'\ 20'' \\
\text{Off the arc,} & +33\ \ 10 \\
\hline
2) & +\ 1\ \ 50 \\
\hline
\text{I. C.,} & +\ 0\ \ 55
\end{array}
$$

**251.** From the equations previously given, it is seen that:

$$S = \tfrac{1}{2}(r - r');$$

hence, if the observations are correct, it will be found that the sun's semidiameter, as given in the Nautical Almanac for the day of observation, is equal to one-half the algebraic difference of the readings. If required to obtain the index correction with great precision, several observations should be taken and the mean used, the accuracy being verified by comparing the tabulated with the observed semidiameter. If the sun is low, the horizontal semidiameter should be observed, to prevent the error that may arise from unequal refraction.

**252.** USE OF THE SEXTANT.—To measure the angle between any two visible objects, point the telescope toward the lower one, if one is above the other, or toward the left-hand one, if they are in nearly the same horizontal plane. Keep this object in direct view through the unsilvered part of the horizon glass, and move the index arm until the image of the other object is seen by a double reflection from the index mirror and the silvered portion of the horizon glass. Having gotten the direct image of one object into nearly exact contact with the reflected image of the other, clamp the index arm and, by means of the tangent-screw, complete the adjustment so that the contact may be perfect; then read the limb.

In measuring the altitude of a celestial body above the sea horizon, it is necessary that the angle shall be measured to that point of the horizon which lies vertically beneath the object. To determine this point, the observer should move the instrument slightly to the right and left of the vertical, swinging it about the line of sight as an axis, taking care to keep the object in the middle of the field of view. The object will appear to describe the arc of a circle, and the lowest point of this arc marks the true vertical.

The shade-glasses should be employed as may be necessary to protect the eye when observing objects of dazzling brightness, such as the sun, or the horizon when the sun is reflected from it at a low altitude. Care must be taken that the images are not too bright or the eye will be so affected as to interfere with the accuracy of the observations.

**253.** CHOICE OF SEXTANTS.—The choice of a sextant should be governed by the kind of work which is required to be done. In rough work, such as surveying, where angles need only be measured to the nearest 30″ the radius may be as small as 6 inches, which will permit easy reading, and the instrument can be correspondingly lightened. Where readings to 10″ are desired, as in nice astronomical work, the radius should be about 7½ inches, and the instrument, to be strongly built, should weigh about 3½ pounds.

The parts of an instrument should move freely, without binding or gritting. The eyepieces should move easily in the telescope tubes; the bracket for carrying the telescope should be made very strong. It is frequently found that the parallelism of the line of sight is destroyed in focusing the eyepiece, either on account of the looseness of the fit or because of the telescope bracket being weak. The vernier should lie close to the limbs to prevent parallax in reading. If it is either too loose or too tight at either extremity of its travel, it may indicate that the pivot is not perpendicular. The balls of the tangent-screw should fit snugly in their sockets, so that there may be no lost motion.

Where possible, the sextant should always be submitted to expert examination and test as to the accuracy of its permanent adjustments before acceptance by the navigator.

**254.** RESILVERING MIRRORS.—Occasion may sometimes arise for resilvering the mirrors of a sextant, as they are always liable to be damaged by dampness or other causes. For this purpose some

clean tin foil and mercury are required. Upon a piece of glass about 4 inches square lay a piece of tin foil whose dimensions exceed by about a quarter of an inch in each direction those of the glass to be silvered; smooth out the foil carefully by rubbing; put a small drop of mercury on the foil and spread it with the finger over the entire surface, being careful that none shall find its way under the foil; then put on a few more drops of mercury until the whole surface is fluid. The glass which is to be silvered having been carefully cleaned, it should be laid upon a piece of tissue paper whose edge just covers the edge of the foil and transferred carefully from the paper to the tin foil, a gentle pressure being kept upon the glass to avoid the formation of bubbles; finally, place the mirror face downward and leave it in an inclined position to allow the surplus mercury to flow off, the latter operation being hastened by a strip of tin foil at its lower edge. After five or six hours the tin foil around the edges may be removed, and the next day a coat of varnish made from spirits of wine and red sealing wax should be applied. For a horizon mirror care must be taken to avoid silvering the plain half. The mercury drawn from the foil should not be placed with clean mercury with a view to use in the artificial horizon or the whole will be spoiled.

**255.** OCTANTS AND QUINTANTS.—Properly speaking, a sextant is an instrument whose arc covers one-sixth of a complete circle, and which is therefore capable of measuring an angle of 120°. Other instruments are made which are identical in principle with the sextant as heretofore described, and which differ from that instrument only in the length of the arc. These are the *octant*, an eighth of a circle, bv which angles may be measured to 90°, and the *quintant*, a fifth of a circle, which measures angles up to 144°. The distinction between these instruments is not always carefully made, and in such matters as have been touched upon in the foregoing articles the sextant may be regarded as the type of all kindred reflecting instruments.

## THE ARTIFICIAL HORIZON.

**256.** The *Artificial Horizon* is a small, rectangular, shallow basin of mercury, over which, to protect the mercury from agitation by the wind, is placed a roof consisting of two plates of glass at right angles



FIG. 33.

to each other. The mercury affords a perfectly horizontal surface which is at the same time an excellent mirror. The different parts of an artificial horizon are furnished in a compact form, a metal bottle being provided for containing the mercury when not in use, together with a suitable funnel for pouring.

If MN, in figure 33, is the horizontal surface of the mercury; S'B a ray of light from a celestial object, incident to the surface at B; BA the reflected ray; then an observer at A will receive the ray BA as if it proceeded from a point S'', whose angular depression, MBS'', below the horizontal plane is equal to the altitude, MBS', of the object above that plane. If, then, SA is a direct ray from the object parallel to S'B, an observer at A can measure with the sextant the angle SAS''= S'BS''= 2 S'BM, by bringing the image of the object reflected by the index mirror into coincidence with the image S'' reflected by the mercury and seen through the horizon glass. The instrumental measure, corrected for index error, will be double the apparent altitude of the body.

The sun's altitude will be measured by bringing the lower limb of one image to touch the upper limb of the other. Half the corrected instrumental reading will be the apparent altitude of the sun's *lower* or *upper* limb, according as the lower or upper limb of the *reflected* image was the one employed in the observation.

In observations of the sun with the artificial horizon, the eye is protected by a single dark glass over the eyepiece of the telescope through which direct and reflected rays must pass alike, thereby avoiding the errors that might possibly arise from a difference in the separate shade glasses attached to the frame of the sextant.

The glasses in the roof over the mercury should be made of plate-glass, with perfectly parallel faces. If they are at all prismatic, the observed altitude will be erroneous. The error may be removed by observing a second altitude with the roof reversed, and, in general, by taking one half of a set of observations with the roof in one position and the other half with the roof reversed. On the rare occasions when the atmosphere is so calm that the unsheltered mercury will remain undisturbed, most satisfactory observations may be made by leaving off the roof.

**257.** In setting up an artificial horizon, care should be taken that the basin is free from dust and other foreign matter, as small particles floating upon the surface of the mercury interfere with a perfect reflection. The basin should be so placed that its longer edge lies in the direction in which the observed body will bear at the middle of the observations. The spot selected for taking the sights should be as free as possible from causes which will produce vibration of the mercury, and precautions should be taken to shelter the horizon from the wind, as the mere placing of the roof will not ordinarily be sufficient to accomplish this. Embedding the roof in earth serves to keep out the wind, while setting the whole horizon upon a thick towel or a piece of such material as heavy felt usually affords ample protection from wind, tends to reduce the vibrations from mechanical shocks, and also aids in keeping out the moisture from the ground. In damp climates the roof should be kept dry by wiping, or the moisture deposited from the inclosed air will form a cloud upon the glass.

Molasses, oil, or other viscous fluid may, when necessary, be employed as a substitute for mercury.
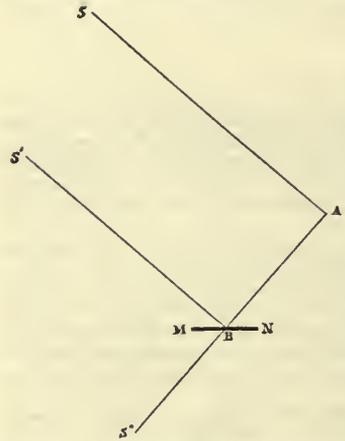
**258.** Owing to the perfection of manufacture that is required to insure accuracy of results with the artificial horizon, navigators are advised to accept only such instrument as has satisfactorily stood the necessary tests to prove the correctness of its adjustment as regards the glasses of the roof.

## THE CHRONOMETER.

**259.** The *Chronometer* is simply a correct time-measurer, differing from an ordinary watch in having the force of its main-spring rendered uniform by means of a variable lever. Owing to the fact that on a sea voyage a chronometer is exposed to many changes of temperature, it is furnished with an expansion balance, formed of a combination of metals of different expansive qualities, which produces the required compensation. In order that its working may not be deranged by the motion of the ship in a seaway, the instrument is carried in gimbals.

As the regularity of the chronometer is essential for the correct determination of a ship's position, it is of the greatest importance that every precaution be taken to insure the accuracy of its indications. There is no more certain way of doing this than to provide a vessel with several of these instruments—preferably not less than three—in order that if an irregularity develop in one, the fact may be revealed by the others.

**260.** Care of Chronometers on Shipboard.—The box in which the chronometers are kept should have a permanent place as near as practicable to the center of motion of the ship, and where it will be free from excessive shocks and jars, such as those that arise from the engines or from the firing of heavy guns; the location should be one free from sudden and extreme changes of temperature, and as far removed as possible from masses of vertical iron. The box should contain a separate compartment for each chronometer, and each compartment should be lined with baize cloth padded with curled hair, for the double purpose of reducing shocks and equalizing the temperature within. An outer cover of baize cloth should be provided for the box, and this should be changed or dried out frequently in damp weather. The chronometers should all be placed with the XII mark in the same position.

For transportation for short distances by hand, an instrument should be rigidly clamped in its gimbals, for if left free to swing, its performance may be deranged by the violent oscillations that are imparted to it.

For transportation for a considerable distance, as by express, the chronometer should be allowed to run down, and should then be dismounted and the balance corked.

**261.** Since it is not possible to make a perfect instrument which will be uninfluenced by the disturbing causes incident to a sea voyage, it becomes the duty of the navigator to determine the *error* and to keep watch upon the variable *rate* of the chronometer.

The *error of the chronometer* is the difference between the time indicated and the standard time to which it is referred—usually Greenwich mean time.

The amount the chronometer *gains* or *loses* daily is the *daily rate*.

The indications of a chronometer at any given instant require a correction for the accumulated error to that instant; and this can be found if the error at any given time, together with the daily rate, are known.

**262.** Winding.—Chronometers are ordinarily constructed to run for 56 hours without rewinding, and an indicator on the face always shows how many hours have elapsed since the last winding. To insure a uniform rate, they must be wound regularly every day, and, in order to avoid the serious consequences of their running down, the navigator should take some means to guard against neglecting this duty through a fault of memory. To wind, turn the chronometer gently on its side, enter the key in its hole and push it home, steadying the instrument with the hand, and wind to the left, the last half turn being made so as to bring up gently against the stop. After winding, cover the keyhole and return the instrument to its natural position. Chronometers should always be wound in the same order to prevent omissions, and the precaution taken to inspect the indicators, as a further assurance of the proper performance of the operation.

After winding each day, the comparisons should be made, and, with the readings of the maximum-and-minimum thermometer and other necessary data, recorded in a book kept for the purpose.

The maximum-and-minimum thermometer is one so arranged that its highest and lowest readings are marked by small steel indices that remain in place until reset. Every chronometer box should be provided with such an instrument, as a knowledge of the temperature to which chronometers have been subjected is essential in any analysis of the rate. To draw down the indices for the purpose of resetting, a magnet is used. This magnet should be kept at all times at a distance from the chronometers.

**263.** Comparison of Chronometers.—The instrument believed to be the best is regarded as the *Standard*, and each other is compared with it. It is usual to designate the Standard as A, and the others as B, C, etc. Chronometers are made to beat half-seconds, and any two may be compared by following the beat of one with the ear and of the other with the eye.

To make a comparison, say of A and B, open the boxes of these two instruments and close all others. Get the cadence and, commencing when A has just completed the beat of some even 5-second division of the dial, count "half-one-half-two-half-three-half-four-half-five," glancing at B in time to note the position of its second-hand at the last count; the seconds indicated by A will be five greater than the number at the beginning of the count. The hours and minutes are also recorded for each chronometer, and the subtraction made. A good check upon the accuracy is afforded by repeating the operation, taking the tick from B.

Where necessary for exact work, it is possible to estimate the fraction between beats, and thus make the comparison to tenths of a second; but the nearest half-second is sufficiently exact for the purposes of ordinary navigation at sea.

**264.** The following form represents a convenient method of recording comparisons:

STAND. A, No. 777.            CHRO. B, No. 1509.            CHRO. C, No. 1802.

| Date, 1903. | Designation of comparisons. | Chro. B with Stand. A. | 2d diff. | Chro. C with Stand. A. | 2d diff. | Therm. | | | Bar. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max. | Min. | Air. | | |
| January 1 | Stand. A. B and C. | *h. m. s.* 1 13 40 1 12 21.5 | *s.* | *h. m. s.* 1 14 20 2 04 11 | *s.* | ° 63 | ° 59 | ° 60 | '' 30. 07 | Found errors by time-ball. |
| | Difference. | 1 18.5 | — | 11 10 09 | — | | | | | |
| 2 | Stand. A. B and C. | 1 16 30 1 15 10 | | 1 17 00 2 06 51.5 | | 64 | 58 | 57 | 30. 12 | Left New York for San Juan, P. R. |
| | Difference. | 1 20 | +1.5 | 11 10 08.5 | —0. 5 | | | | | |

**265.** The *second difference* in the form is the difference between the comparisons of the same instruments for two successive days. When a vessel is equipped with only one chronometer there is nothing to indicate any irregularity that it may develop at sea—and even the best instruments may undergo changes from no apparent cause. When there are two chronometers, the second difference, which is equal to the algebraic difference between their daily rates, remains uniform as long as the rates remain uniform, but changes if one of the rates undergoes a change; in such a case, there is no means of knowing which chronometer has departed from its expected performance, and the navigator must proceed with caution, giving due faith to the indications of each. If, however, there are three chronometers, an irregularity on the part of one is at once located by a comparison of the second differences. Thus, if the predicted rates of the chronometers were such as to give for the second difference of A — B, + $1^s.5$, and of A — C, — $0^s.5$, suppose on a certain day those differences were + $4^s.5$ and — $0^s.5$, respectively; it would at once be suspected that the irregularity was in B, and that that chronometer had lost $3^s$ on its normal rate during the preceding day. Suppose, however, the second differences were + $4^s.5$ and + $2^s.5$; it would then be apparent that A had gained $3^s$.

**266.** TEMPERATURE CURVES.—Notwithstanding the care taken to eliminate the effect of a change of temperature upon the rate of a chronometer, it is rare that an absolutely perfect compensation is attained, and it may therefore be assumed that the rates of all chronometers vary somewhat with the temperature. Where the voyage of a vessel is a long one and marked changes of climate are encountered, the accumulated error from the use of an incorrect rate may be very material, amounting to several minutes' difference of longitude. Careful navigators will therefore take every means to guard against such an error. By the employment of a *temperature curve* in connection with the chronometer rate the most satisfactory results are arrived at.

**267.** There should be furnished with each chronometer a statement showing its daily rate under various conditions of temperature; and this may be supplemented by the observations of the navigator during the time that the chronometer remains on board ship. With all available data a temperature curve should be constructed which will indicate graphically the performance of the instrument. It is most convenient to employ for this purpose a piece of "profile paper," on which parallel lines are ruled at equal intervals at right angles to each other. Let each horizontal line represent, say, a degree of temperature, numbered at the left edge, from the bottom up; draw a vertical line in red ink to represent the zero rate, and let all rates to the right be *plus*, or gaining, and those to the left *minus*, or losing; let the intervals between vertical lines represent intervals of rate (as one-tenth of a second) numbered at the top from the zero rate; then on this scale plot the rate corresponding to each temperature; when there are several observations covering one height of the thermometer, the mean may be used. Through all the plotted points draw a fair curve, and the intersection of this curve with each temperature line gives the mean rate at that temperature. The mean temperature given by the maximum and minimum thermometer shows the rate to be used on any day.

**268.** HACK OR COMPARING WATCH.—In order to avoid derangement, the chronometers should never be removed from the permanent box in which they are kept on shipboard. When it is desired to mark a certain instant of time, as for an astronomical observation or for obtaining the chronometer error by signal, the time is marked by a "hack" (an inferior chronometer used for this purpose only), or by a comparing watch. Careful comparisons are taken—preferably both before and afterwards—and the chronometer time at the required instant is thus deduced. The correction represented by the chronometer time *minus* the watch time (twelve hours being added to the former when necessary to make the subtraction possible) is referred to as C — W. Suppose, for example, the chronometer and watch are compared and their indications are as follows:

$$\begin{array}{ll} \text{Chro. t.,} & 5^h\ 27^m\ 30^s \\ \text{W. T.,} & -2\ 36\ 45.5 \\ \hline \text{C} - \text{W,} & 2\ 50\ 44.5 \end{array}$$

If then a sight is taken when the watch shows $3^h\ 01^m\ 27^s.5$, we have:

$$\begin{array}{ll} \text{W. T.,} & 3^h\ 01^m\ 27^s.5 \\ \text{C} - \text{W,} & +2\ 50\ 44.5 \\ \hline \text{Chro. t.,} & 5\ 52\ 12.0 \end{array}$$

It may occur that the values of $C - W$, as obtained from comparisons before and after marking the desired time, will vary; in that case the value to be used will be the mean of the two, if the time marked is about midway between comparisons, but if much nearer to one comparison than the other, allowance should be made accordingly.

Thus suppose, in the case previously given, a second comparison had been taken after the sight as follows:

$$\begin{array}{lr} \text{Chro. t.,} & 6^\text{h}\ 12^\text{m}\ 45^\text{s} \\ \text{W. T.,} & -3\ \ 21\ \ 59.5 \\ \hline \text{C} - \text{W,} & 2\ \ 50\ \ 45.5 \end{array}$$

The sight having been taken at about the middle of the interval, the $C - W$ to be used would be the mean of the two, or $2^\text{h}\ 50^\text{m}\ 45^\text{s}.0$.

Let us assume, however, that the second comparison showed the following:

$$\begin{array}{lr} \text{Chro. t.,} & 6^\text{h}\ 38^\text{m}\ 25^\text{s} \\ \text{W. T.,} & -3\ \ 47\ \ 39 \\ \hline \text{C} - \text{W,} & 2\ \ 50\ \ 46 \end{array}$$

Then, the sight having been taken when only about one-third of the interval had elapsed between the first and second comparisons, it would be assumed that only one-third of the total change in the $C - W$ had occurred up to the time of sight, and the value to be used would be $2^\text{h}\ 50^\text{m}\ 45^\text{s}.0$.

**269.** It is considered a good practice always to subtract watch time from chronometer time whatever the relative values, and thus to employ $C - W$ invariably as an additive correction. It is equally correct to take the other difference, $W - C$, and make it subtractive; it may sometimes occur that a few figures will thus be saved, but a chance for error arises from the possibility of inadvertently using the wrong sign, which is almost impossible by the other method. Thus, the following example may be taken:

$$\text{Comparison} \left\{ \begin{array}{lr} \text{C,} & 10^\text{h}\ 57^\text{m}\ 38^\text{s} \\ \text{W,} & -11\ \ 42\ \ 35 \\ \hline \text{C}-\text{W,} & 11\ \ 15\ \ 03 \end{array} \right. \qquad \begin{array}{lr} \text{W,} & 11^\text{h}\ 42^\text{m}\ 35^\text{s} \\ \text{C,} & -10\ \ 57\ \ 38 \\ \hline \text{W}-\text{C,} & 0\ \ 44\ \ 57 \end{array}$$

$$\text{Sight} \left\{ \begin{array}{lr} \text{W,} & 11\ \ 50\ \ 21 \\ \text{C}-\text{W,} +& 11\ \ 15\ \ 03 \\ \hline \text{C,} & 11\ \ 05\ \ 24 \end{array} \right. \qquad \begin{array}{lr} \text{W,} & 11\ \ 50\ \ 21 \\ \text{W}-\text{C,} - & 0\ \ 44\ \ 57 \\ \hline \text{C,} & 11\ \ 05\ \ 24 \end{array}$$

# CHAPTER IX.

## TIME AND THE NAUTICAL ALMANAC.

**270.** The subjects of *Time* and the *Nautical Almanac* are two of the most important ones to be mastered in the study of Nautical Astronomy, as they enter into every operation for the astronomical determination of a ship's position. They will be treated in conjunction, as the two are interdependent.

### METHODS OF RECKONING TIME.

**271.** The instant at which any point of the celestial sphere is on the meridian of an observer is termed the *transit, culmination,* or *meridian passage* of that point; when on that half of the meridian which contains the zenith, it is designated as *superior* or *upper* transit; when on the half containing the nadir, as *inferior* or *lower* transit.

**272.** Three different kinds of time are employed in astronomy—(*a*) *apparent* or *solar time,* (*b*) *mean time,* and (*c*) *sidereal time.* These depend upon the hour angle from the meridian of the points to which they respectively refer. The point of reference for apparent or solar time is the *Center of the Sun;* for mean time, an imaginary point called the *Mean Sun;* and for sidereal time, the *Vernal Equinox,* also called the *First Point of Aries.*

The unit of time is the *Day,* which is the period between two successive transits over the same branch of the meridian of the point of reference. The day is divided into 24 equal parts, called *Hours;* these into 60 equal parts, called *Minutes,* and these into 60 equal parts, called *Seconds.*

**273.** Apparent or Solar Time.—The hour angle of the center of the sun affords a measure of *Apparent* or *Solar Time.* An *Apparent* or *Solar Day* is the interval of time between two successive transits over the same meridian of the center of the sun. It is *Apparent Noon* when the sun's hour circle coincides with the celestial meridian. This is the most natural and direct measure of time, and the unit of time adopted by the navigator at sea is the apparent solar day. Apparent noon is the time when the latitude can be most readily determined, and the ordinary method of determining the longitude by the sun involves a calculation to deduce the apparent time first.

Since, however, the intervals between the successive returns of the sun to the same meridian are not equal, apparent time can not be taken as a standard. The apparent day varies in length from two causes: first, the sun does not move in the equator, the great circle perpendicular to the axis of rotation of the earth, but in the ecliptic; and, secondly, the sun's motion in the ecliptic is not uniform. Sometimes the sun describes an arc of 57' of the ecliptic, and sometimes an arc of 61' in a day. At the points where the ecliptic and equinoctial intersect, the direction of the sun's apparent motion is inclined at an angle of 23° 27' to the equator, while at the solstices it moves in a direction parallel to the equator.

**274.** Mean Time.—To avoid the irregularity of time caused by the want of uniformity in the sun's motion, a fictitious sun, called the *Mean Sun,* is supposed to move in the *equinoctial* with a uniform velocity that equals the *mean velocity of the true sun in the ecliptic.* This mean sun is regarded as being in coincidence with the true sun at the vernal equinox, or First Point of Aries.

*Mean Time* is the hour angle of the mean sun. A *Mean Day* is the interval between two successive transits of the mean sun over the meridian. *Mean Noon* is the instant when the mean sun's hour circle coincides with the meridian.

Mean time lapses uniformly; at certain times it agrees with apparent time, while sometimes it is behind, and at other times in advance of it. It is this time that is measured by the clocks in ordinary use, and to this the chronometers used by navigators are regulated.

**275.** The difference between apparent and mean time is called the *Equation of Time;* by this quantity, the conversion from one to the other of these times may be made. Its magnitude and the direction of its application may be found for any moment from the Nautical Almanac.

**276.** Sidereal Time.—*Sidereal Time* is the hour angle of the First Point of Aries. This point, which is identical with the vernal equinox, is the origin of all coordinates of right ascension. Since the position of the point is fixed in the celestial sphere and does not, like the sun, moon, and planets, have actual or apparent motion therein, it shares in this respect the properties of the fixed stars. It may therefore be said that intervals of sidereal time are those which are measured by the stars.

A *Sidereal Day* is the interval between two successive transits of the First Point of Aries across the same meridian. *Sidereal Noon* is the instant at which the hour circle of the First Point of Aries coincides with the meridian. In order to interconvert sidereal and mean times an element is tabulated in the Nautical Almanac. This is the *Sidereal Time of Mean Noon,* which is also the *Right Ascension of the Mean Sun.*

**277.** Civil and Astronomical Time.—The *Civil Day* commences at midnight and comprises the twenty-four hours until the following midnight. The hours are counted from 0 to 12, from midnight to noon; then, again, from 0 to 12, from noon to midnight. Thus the civil day is divided into two periods of twelve hours each, the first of which is marked a. m. (ante meridian), while the last is marked p. m. (post meridian).

The *Astronomical* or *Solar Day* commences at noon of the civil day of the same date. It comprises twenty-four hours, reckoned from 0 to 24, from noon of one day to noon of the next. Astronomical time (apparent or mean) is the hour angle of the sun (true or mean) measured to the westward throughout its entire circuit from the time of its upper transit on one day to the same instant of the next.

The civil day, therefore, begins twelve hours before the astronomical day, and a clear understanding of this fact is all that is required for interconverting these times. For example:

January 9, 2 a. m., civil time, is January 8, $14^h$, astronomical time.

January 9, 2 p. m., civil time, is January 9, $2^h$, astronomical time.

**278.** Hour Angle.—The *hour angle* of a heavenly body is the angle at the pole of the celestial concave between the declination circle of the heavenly body and the celestial meridian. It is measured by the arc of the celestial equator between the declination circle and the celestial meridian.

In figure 34 let P be the pole of the celestial sphere, of which VMQ is the equator, PQ, the celestial meridian, and PM, PS, PV, the declination circles of the mean sun, a heavenly body, and the First Point of Aries, respectively.

Then QPM, or its arc, QM, is the hour angle of the mean sun, or the mean time; QPS, or QS, the hour angle of the heavenly body; QPV, or QV, the hour angle of the First Point of Aries, or the right ascension of the meridian, both of which are equivalent to the sidereal time; VPS, or VS, the right ascension of the heavenly body; and VPM, or VM, the right ascension of the mean sun.

Fig. 34.

**279.** Time at Different Meridians.—The hour angle of the true sun at any meridian is called the *local apparent time;* that of the mean sun, the *local mean time;* that of the First Point of Aries, the *local sidereal time.* The hour angles of the same body and points from Greenwich are respectively the *Greenwich apparent, mean,* and *sidereal times.* The difference between the local time at any meridian and the Greenwich time is equal to the longitude of that place from Greenwich expressed in time; the conversion from time to arc may be effected by a simple mathematical calculation or by the use of Table 7.

In comparing corresponding times of different meridians the most easterly meridian may be distinguished as that at which the time is *greatest* or *latest.*

In figure 35 PM and PM′ represent the celestial meridians of two places; PS, the declination circle through the sun, and PG, the Greenwich meridian; let $T_G$ = the Greenwich time = GPS;

$T_M$ = the corresponding local time at all places on the meridian PM = MPS;

$T_{M'}$ = the corresponding local time at all places on the meridian PM′ = M′PS;

Lo = west longitude of meridian PM = GPM; and

Lo′ = east longitude of meridian PM′ = GPM′.

If west longitudes and hour angles be reckoned as positive, and east longitudes and hour angles as negative, we have:

Fig. 35.

$$Lo = T_G - T_M; \text{ and}$$
$$Lo' = T_G - T_{M'}; \text{ therefore,}$$
$$Lo - Lo' = T_{M'} - T_M.$$

Thus it may be seen that the difference of longitude between two places equals the difference of their local times. This relation may be shown to hold for any two meridians whatsoever.

Both local and Greenwich times in the above formulæ must be reckoned westward, always from their respective meridians and from $0^h$ to $24^h$; in other words, it is the astronomical time which should be used in all astronomical computations.

The formula $Lo = T_G - T_M$ is true for any kind of time, solar or sidereal; or, in general terms, $T_G$ and $T_M$ are the hour angles of any point of the sphere at the two meridians whose difference of longitude is Lo. S may be the sun (true or mean) or the vernal equinox.

**280.** Finding the Greenwich Time.—Since nearly every computation made by the navigator requires a knowledge of the Greenwich date and time as a preliminary to the use of the Nautical Almanac, the first operation necessary is to deduce from the local time the corresponding Greenwich date, either exact or approximate, and thence the Greenwich time expressed astronomically. The formula is:

$$T_G = T_M + Lo,$$

remembering that west longitudes are positive, east longitudes are negative. Hence the following rule for converting local to Greenwich time:

Having expressed the local time astronomically, *add* the longitude if *west*, *subtract* it if *east;* the result is the corresponding Greenwich time.

EXAMPLE: In longitude 81° 15′ W. the local time is, 1879, April, $15^d$ $10^h$ $17^m$ $30^s$ a. m. Required the Greenwich time.

| | | | | |
|---|---|---|---|---|
| Local Ast. time, April, | $14^d$ | $22^h$ | $17^m$ | $30^s$ |
| Longitude, | + | 5 | 25 | 00 |
| Greenwich time, | 15 | 3 | 42 | 30 |

EXAMPLE: In longitude 81° 15′ E. the local time is, August, $5^d$ $2^h$ $10^m$ $30^s$ p. m. Required the Greenwich time.

| | | | | |
|---|---|---|---|---|
| Local Ast. time, | $5^d$ | $2^h$ | $10^m$ | $30^s$ |
| Longitude, | — | 5 | 25 | 00 |
| Greenwich time, | 4 | 20 | 45 | 30 |
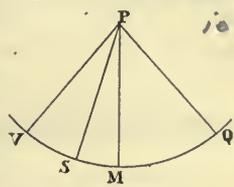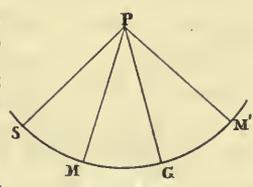
EXAMPLE: In longitude 17° 28′ W. the local time is, May, 1$^d$ 3$^h$ 10$^m$ p. m.   Required the Greenwich time.

| | |
|---|---|
| Local Ast. time, | 1$^d$ 3$^h$ 10$^m$ 00$^s$ |
| Longitude, | + 1 09 52 |
| Greenwich time, | 1 4 19 52 |

EXAMPLE: In longitude 125° 30′ E. the local time is, May, 1$^d$ 8$^h$ 10$^m$ 30$^s$ a. m.   Required the Greenwich time.

| | |
|---|---|
| Local Ast. time, April, | 30$^d$ 20$^h$ 10$^m$ 30$^s$ |
| Longitude, | − 8 22 00 |
| Greenwich time, | 30 11 48 30 |

**281.** From the preceding article we have:

$$T_G = T_M + Lo; \text{ hence,}$$
$$T_M = T_G − Lo;$$

thus it will be seen that, to find the local time corresponding to any Greenwich time, the above process is simply reversed.

Since all observations at sea are referred to chronometers regulated to Greenwich mean time, and as these instruments are usually marked on the dial from 0$^h$ to 12$^h$, it becomes necessary to distinguish whether it is a.m. or p.m. at Greenwich.   Therefore, an approximate knowledge of the longitude and local time is necessary to determine the Greenwich date.

EXAMPLE: In longitude 5$^h$ 00$^m$ 00$^s$ W., about 3$^h$ 30$^m$ p.m. April 15th, the Greenwich chronometer read 8$^h$ 25$^m$, and was fast of Gr. time 3$^m$ 15$^s$.   Required the local astronomical time.

| | | | | | |
|---|---|---|---|---|---|
| Aprox. local time, | 15$^d$ 3$^h$ 30$^m$ | Gr. chro., | 8$^h$ 25$^m$ 00$^s$ | Gr. Ast. time 15$^d$, | 8$^h$ 21$^m$ 45 |
| Longitude, | + 5 00 | Corr., | − 3 15 | Longitude, | −5 00 00 |
| Approx. Gr. time, | 15 8 30 | Gr. Ast. time 15$^d$, | 8 21 45 | Local Ast. time 15$^d$, | 3 21 45 |

EXAMPLE: In longitude 5$^h$ 00$^m$ 00$^s$ E., about 8 a. m. May 3d, the Gr. chro. read 3$^h$ 15$^m$ 20$^s$, and was fast of Gr. time 3$^m$ 15$^s$.   Required the local astronomical time.

| | | | | | |
|---|---|---|---|---|---|
| Approx. local time, May, | 2$^d$ 20$^h$ | Gr. chro., | 3$^h$ 15$^m$ 20$^s$ | Gr. Ast. time 2$^d$, | 15$^h$ 12$^m$ 05 |
| Longitude, | − 5 | Corr., | − 3 15 | Longitude, | + 5 00 00 |
| Approx. Gr. time, | 2 15 | Gr. Ast. time 2$^d$, | 15 12 05 | Local Ast. time 2$^d$, | 20 12 05 |

## THE NAUTICAL ALMANAC. [a]

**282.** *The American Ephemeris and Nautical Almanac* is divided into four parts, as follows: Part I, Ephemeris for the meridian of Greenwich, gives the ephemerides of the sun and moon, the geocentric and heliocentric positions of the major planets, the sun's coordinates, and other fundamental astronomical data for equidistant intervals of Greenwich mean time; Part II, Ephemeris for the meridian of Washington, gives the ephemerides of the fixed stars, sun, moon, and major planets for transit over the meridian of Washington; Part III, Phenomena, contains predictions of phenomena to be observed, with data for their computation; and Part IV, Star Numbers and other data, contains matter relating to certain fixed stars.   Tables are also appended for the interconversion of mean and sidereal time and for finding the latitude by an altitude of Polaris.

*The American Nautical Almanac* is a smaller book made up of extracts from the "Ephemeris and Almanac" just described, and is designed especially for the use of navigators, being adapted to the meridian of Greenwich.   It contains the positions of the sun and moon, the distances of the moon from the center of the sun, from the centers of the four most conspicuous planets, and from certain fixed stars, together with the ephemerides of the planets Mercury, Venus, Mars, Jupiter, and Saturn, and the mean places of 150 fixed stars; solar and lunar eclipses are described, and the tables for the interconversion of mean and sidereal time and for finding the latitude by Polaris are included.

The elements dependent upon the sun and moon are placed at the beginning of the book, arranged according to the months of the year; eighteen pages are devoted to each month, numbered in Roman notation from I to XVIII.   Of these, page I contains the Apparent Right Ascension and Declination of the sun and the Equation of Time for the instant of Greenwich *apparent* noon; throughout the remaining seventeen pages Greenwich *mean* time forms the basis of reckoning.   Page I is used in computations from observations that depend upon the time of the sun's meridian passage, at which instant the local apparent time is 0$^h$, and the Greenwich apparent time is equal to the longitude, if west, or to 24$^h$ *minus* the longitude, if east; this page therefore affords a means for reducing the elements for such observations from a knowledge of the longitude alone.   In all other observations the calculation is made for some definite instant of Greenwich *mean* time (usually as noted by the chronometer), in which case Pages II to XVIII are employed.

**283.** REDUCTION OF ELEMENTS.—The reduction of elements in the Nautical Almanac is usually accomplished by *Interpolation*, but in certain cases where extreme precision is necessary the method of *Second Differences* must be used.

---

[a] See extracts from Ephemeris and Nautical Almanac for 1879, Appendix I.

The Ephemeris, being computed for the Greenwich meridian, contains the right ascensions, declinations, equations of time, and other elements for given equidistant intervals of Greenwich time. Hence, before the value of any of these quantities can be found for a given local time it is necessary to determine the corresponding Greenwich time. Should that time be one for which the Nautical Almanac gives the value of the required element, nothing more is necessary than to employ that value. But if the time falls between the Almanac times, the required quantity must be found by interpolation.

The Almanac contains the rate of change or difference of each of the principal quantities for some unit of time, and, unless great precision is required, the first differences only need be regarded. In order to use the difference columns to advantage, the Greenwich date should be expressed in the unit of time for which the difference is given. Thus, for using the hourly differences, the Greenwich time should be expressed in hours and decimal parts of an hour; when using the differences for one minute, the time should be in minutes and decimal parts of a minute. Instead of using decimal parts, some may prefer the use of aliquot parts.

Since the quantities in the Almanac are approximate numbers, given to a certain decimal, any interpolation of a lower order than that decimal is unnecessary work. Moreover, since, in computations at sea, the Greenwich time is more or less inexact, too great refinement need not be sought in reducing the Almanac elements.

Simple interpolation assumes that the differences of the quantities are proportional to the differences of the times; in other words, that the differences given in the Almanac are constant; this is seldom the case, but the error arising from the assumption will be smaller the less the interval between the times in the Almanac. Hence those quantities which vary most irregularly are given for the smallest units of time; as the variations are more regular, the units for which the differences are given increase.

In taking from the Almanac the elements relating to the fixed stars the data may be found either in the table which gives the "mean place" of each star for the year or in that which gives the "apparent place" occupied by each one on every tenth day throughout the year. As the annual variation of position of the fixed stars is small, the results will not vary greatly whichever table may be used. Yet, as it is proper to seek always the greatest attainable accuracy, the use of the table showing the exact positions is recommended. That table is, however, published in the "Ephemeris and Nautical Almanac" only, and is omitted from the abridged "Nautical Almanac;" hence, where the larger book is not at hand, the table of mean places must be employed.

**284.** To find from the Nautical Almanac a required element for any given time and place, it is first necessary to express the time astronomically and to convert it to Greenwich time and date. Then take from the Almanac, for the nearest given *preceding* instant, the required quantity, together with its corresponding "Diff. for 1$^h$" or "Diff. for 1$^m$," noting the name or sign in each case; for the sun use Page I of the proper month in the Almanac when *apparent* time is to be the basis for correction, but otherwise use Page II. Multiply the "Diff. for 1$^h$" by the number of hours and fraction of an hour, or the "Diff. for 1$^m$" by the number of minutes and fraction of a minute, corresponding to the interval between the time for which the quantity is given in the Almanac and the time for which required; apply the correction thus obtained, having regard to its sign.

A modification of this rule may be adopted if the time for which the quantity is desired falls considerably nearer a *subsequent* time given in the Almanac than it does to one preceding; in this case the interpolation may be made backward, the sign of application of the correction being reversed.

EXAMPLE: At a place in longitude 81° 15′ W., April 17, 1879, find the sun's declination and the equation of time at apparent noon.

Long. = 81° 15′ W.          G. A. T. = 17$^d$ 5$^h$ 25$^m$ = 17$^d$ + 5$^h$.42.

| Dec., 17$^d$ 0$^h$, | (+) 10° 26′ 42″.3 N. | Eq. t., 17$^d$ 0$^h$, | 0$^m$ 24$^s$.46 |
| Corr., | + 4 46 .2 | Corr., + | 3 .18 |

| Dec., 17$^d$ 5$^h$ 25$^m$, | 10 31 28 .5 N. | Eq. t., 17$^d$ 5$^h$ 25$^m$, | 0 27 .64 |

| H. D., | + 52″.80 | H. D., + | 0$^s$.587 |
| G. A. T., | + 5$^h$.42 | G. A. T., + | 5$^h$.42 |

| Corr., | + { 286″.18 <br> { 4′46″.18 | Corr., + | 3$^s$.182 |
| | | (*Subtract* from *apparent* time.) | |

EXAMPLE: At a place in Long. 81° 15′ E., April 17, 1879, find the sun's declination and the equation of time at apparent noon.

Long. = 81° 15′ E.          G. A. T. = 16$^d$ 18$^h$ 35$^m$ = 17$^d$ − 5$^h$.42.

| Dec., 17$^d$ 0$^h$, | (+) 10° 26′ 42″.3 N. | Eq. t., 17$^d$ 0$^h$, | 0$^m$ 24$^s$.46 |
| Corr., | − 4 46 .2 | Corr., − | 3 .18 |

| Dec., 16$^d$ 18$^h$ 35$^m$, | 10 21 56 .1 N. | Eq. t., 16$^d$ 18$^h$ 35$^m$, | 0 21 .28 |

| H. D., | + 52″.80 | H. D., + | 0$^s$.587 |
| G. A. T., | − 5$^h$.42 | G. A. T., − | 5$^h$.42 |

| Cor., | − { 286″.18 <br> { 4′ 46″.18 | Corr., − | 3$^s$.182 |

EXAMPLE: April 16, 1879, at 11ʰ 55ᵐ 30ˢ a. m., local mean time, in Long. 81° 15′ W., required the declination and semidiameter of the sun, the equation of time, and the right ascension, declination, horizontal parallax, and semidiameter of the moon and Jupiter.

$$
\begin{array}{lll}
\text{Local mean time,} & 15^d\ 23^h\ 55^m\ 30^s \\
\text{Longitude,} & +\quad\quad 5^h\ 25^m\ 00^s \\
\hline
\text{Greenwich mean time,} & \begin{cases} 16^d\ 5^h\ 20^m\ 30^s \\ 16^d\ 5^h\ 20^m.5 \\ 16^d\ 5^h.34 \end{cases}
\end{array}
$$

*For the Sun.*

| | | | | | |
|---|---|---|---|---|---|
| Dec., 0ʰ, (+) 10° 05′ 30″. 1 N. | | S. D., | 15′ 58″. 0 | Eq. t., 0ʰ, | 0ᵐ 10ˢ. 15 |
| Corr., + | 4 44 .3 | (Same as at G. A. Noon.) | | Corr., + | 3 .22 |
| Dec., | 10 10 14 .4 N. | | | Eq. t., | 0 13 .37 |
| H. D., + | 53″. 24 | | | H. D., + | 0ˢ. 604 |
| G. M. T., + | 5ʰ. 34 | | | G. M. T., + | 5ʰ. 34 |
| Corr., +{ | 284″. 30 | | | Corr., + | 3ˢ. 22 |
| | 4′ 44″. 30 | | | (*Add* to *mean* time.) | |

*For the Moon.*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R. A., 5ʰ, | 22ʰ 14ᵐ 39ˢ.29 | Dec., 5ʰ, | (−) 7°59′ 36″.1 S. | Hor. Par.,0ʰ, | 55′ 13″.6 | S. D.,0ʰ, | 15′ 04″.7 | |
| Corr., + | 38 .31 | Corr., + | 4 27 .1 | Corr., − | 7 .2 | Corr., − | 1 .9 | |
| R. A., | 22 15 17 .60 | Dec., | 7 55 09 .0 S. | Hor. Par., | 55 06 .4 | S. D., | 15 02 .9 | |
| M. D., + | 1ˢ.869 | M. D., + | 13″.03 | H. D., − | 1.″34 | H. D., − | 0″.34 | |
| No. min., + | 20ᵐ.5 | No. min., + | 20ᵐ.5 | G. M. T., + | 5ʰ.34 | G. M. T., + | 5ʰ.34 | |
| Corr., + | 38ˢ.31 | Corr., +{ | 267″.12 | Corr., − | 7″.15 | Corr., − | 1″.81 | |
| | | | 4′ 27″.1 | | | | | |

*For Jupiter.*

| | | | | | |
|---|---|---|---|---|---|
| R. A., 0ʰ, | 22ʰ 26ᵐ 35ˢ. 54 | Dec., 0ʰ, (−) 10° 40′ 28″. 0 S. | | Hor. Par., 16ᵈ, | 1″. 6 |
| Corr., + | 9 .71 | Corr., + | 53 .6 | | |
| R. A., | 22 26 45 .25 | Dec., | 10 39 34 .4 S. | | |
| H. D., + | 1ˢ. 819 | H. D., + | 10″. 03 | S. D., 16ᵈ, | 16″.9 |
| G. M. T., + | 5ʰ. 34 | G. M. T., + | 5ʰ. 34 | | |
| Corr., + | 9ˢ. 71 | Corr., + | 53″. 6 | | |

**285.** Should greater precision be required than that attainable by simple interpolation, resort must be had to the reduction for second differences.

The differences between successive values of the quantities given in the Nautical Almanac are called the *first differences;* the differences between successive first differences are called the *second differences.* Simple interpolation, which satisfies the necessities of sea computations, assumes the first differences to be constant; but if the variation of the first differences be regarded, a further interpolation is required for the second difference.

The difference for a unit of time in the American Nautical Almanac abreast any element expresses the rate at which the element is changing at that precise instant of Greenwich time. Now, regarding the second difference as constant, the first difference varies uniformly with the Greenwich time; therefore its value may be found for any intermediate time by simple interpolation.

Hence the following rule for second differences: Employ the interpolated value of the first difference which corresponds to the *middle* of the interval for which the correction is to be computed.

EXAMPLE: For the Greenwich date 1879, April. 10ᵈ 18ʰ 25ᵐ 30ˢ, find the moon's declination.

| | | | | |
|---|---|---|---|---|
| Dec., 18ʰ, (−) 26° 19′ 41″.1 S. | | First diff., + 0″.044 | | Second diff., + 0″.181 |
| Corr., + | 2 .1 | Corr., + 0 .039 | | Interval, + 0ʰ.213 |
| Dec., | 26 19 39 .0 S. | M. D., + 0 .083 | | Corr., + 0″.039 |
| | | No. min., + 25ᵐ.5 | | |
| | | Corr., + 2″.12 | | |

The difference for one minute being + 0″.044 at 18ʰ, and + 0″.225 at 19ʰ, the difference for one minute undergoes a change of + 0″.181 during one hour. The time for which it is desired to obtain the difference is at the middle instant between 18ʰ 0ᵐ and 18ʰ 25ᵐ.5—that is, at 18ʰ 12ᵐ.75, or its equivalent, 18ʰ 213. With a change of + 0″.181 in one hour, the change in 0ʰ.213 is readily obtainable; correcting the minute's difference at 18ʰ.0 accordingly, the process of correcting the declination becomes the same as in simple interpolation.

## CONVERSION OF TIMES.

**286.** *Conversion of Time* is the process by which any instant of time that is defined according to one system of reckoning may be defined according to some other system; and also by which any interval of time expressed in units of one system may be converted into units of another.

**287.** SIDEREAL AND MEAN TIMES.—Mean time is the hour angle of the Mean Sun; sidereal time is the hour angle of the First Point of Aries. Since the Right Ascension of the Mean Sun is the angular distance between the hour circles of the Mean Sun and of the First Point of Aries, mean time may be converted into sidereal time by adding to it the Right Ascension of the Mean Sun; and similarly, sidereal time may be converted into mean time by subtracting from it the Right Ascension of the Mean Sun.

This is explained in figure 36, which represents a projection of the celestial sphere upon the equator. If P be the pole; QPQ', the meridian; V, the First Point of Aries; M, the position of the mean sun (west of the meridian); then QPV, or the arc QV, is the sidereal time; QPM, or the arc QM, is the mean time; and VPM, or the arc VM, is the Right Ascension of the Mean Sun. From this it will appear that:
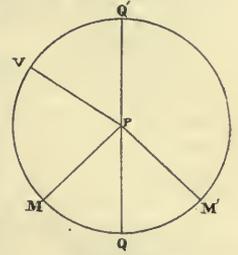


FIG. 36.

$$QV = QM + VM, \text{ or}$$
Sidereal time = Mean time + Right Ascension of Mean Sun.

If the mean sun be on the opposite side of the meridian, at M', then the mean time equals $24^h - M'Q$. In this case:

$$QV = VM' - M'Q, \text{ or}$$
Sidereal time = Right Ascension of Mean Sun $- (24^h - \text{Mean time})$,
$$= \text{Right Ascension of Mean Sun} + \text{Mean time} - 24^h.$$

Right ascension being measured to the east and hour angle to the west, the sidereal time will therefore always equal the sum of these two; but $24^h$ must be subtracted when the sum exceeds that amount.

From the preceding equations, we also have:

$$QM = QV - VM; \text{ and}$$
$$M'Q = VM' - QV, \text{ or}$$
$$(24^h - M'Q) = (24^h + QV) - VM'.$$

From this it may be seen that the mean time equals the sidereal time *minus* the Right Ascension of the Mean Sun, but the former must be increased by $24^h$ when necessary to make the subtraction possible.

**288.** APPARENT AND MEAN TIMES.—Apparent time is the angle between the meridian and the hour circle which contains the center of the sun; mean time is the angle between the meridian and the hour circle which contains the mean sun. Since the equation of time represents the angle between the hour circles of the mean and apparent suns, it is clear that the conversion of mean time to apparent time may be accomplished by the application of the equation of time, with its proper sign, to the mean time; and the reverse operation by the application of the same quantity, in an opposite direction, to the apparent time.

The resemblance of these operations to the interconversion of mean and sidereal times may be observed if, in figure 36, we assume that PV is the hour circle of the true sun, PM remaining that of the mean sun; then the arc QM will be the mean time; QV, the apparent time; and VM, the equation of time; whence we have as before:

$$QV = QM + VM, \text{ or}$$
Apparent time = Mean time + Equation of time;

the equation of time will be positive or negative according to the relative position of the two suns.

**289.** SIDEREAL AND MEAN TIME INTERVALS.—The sidereal year consists of 366.25636 sidereal days or of 365.25636 mean solar days. If, therefore, M be any interval of mean time, and S the corresponding interval of sidereal time, the relations between the two may be expressed as follows:

$$\frac{S}{M} = \frac{366.25636}{365.25636} = 1.0027379;$$

$$\frac{M}{S} = \frac{365.25636}{366.25636} = 0.9972696.$$

Therefore, $S = 1.0027379 \, M = M + .0027379 \, M$;
$$M = 0.9972696 \, S = S - .0027304 \, S.$$

If $M = 24^h$, $S = 24^h + 3^m 56^s.6$; or, in a mean solar day, sidereal time gains on mean time $3^m 56^s.6$, the gain each hour being $9^s.8565$.

If $S = 24^h$, $M = 24^h - 3^m 55^s.9$; or, in a sidereal day, mean time loses on sidereal time $3^m 55^s.9$, the loss each hour being $9^s.8296$.

If M and S be expressed in hours and fractional parts thereof,

$$S = M + 9^s.8565 \, M;$$
$$M = S - 9^s.8296 \, S.$$

Tables for the conversion of the intervals of mean into those of sidereal time and the reverse are based upon these relations. Tables 8 and 9 of this work give the values for making these conversions, and similar tables are to be found in the Nautical Almanac.

**290. To Convert Mean Solar into Sidereal Time.**—Apply to the local mean time the longitude, adding if west and subtracting if east, and thus obtain the Greenwich mean time. Take from the Nautical Almanac the Right Ascension of the Mean Sun at Greenwich mean noon, and correct it for the Greenwich mean time by Table 9 or by the hourly difference of $9^s.857$. Add to the local mean time this corrected right ascension, rejecting $24^h$ if the sum is greater than that amount. The result will be the local sidereal time.

Example: April 22, 1879, in Long. 81° 15′ W., the local mean time is $2^h.00^m.00^s$ p. m. Required the corresponding local sidereal time:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| L. M. T., | $22^d$ $2^h$ $00^m$ $00^s$ | R. A. M. S., $22^d$ $0^h$, | $2^h$ $00^m$ $41^s.24$ | L. M. T., | $2^h$ $00^m$ $00^s$ |
| Long., + | 5 25 00 | Red. for $7^h$ $25^m$ (Tab. 9), + | 1 13 .10 | R. A. M. S., + | 2 01 54.34 |
| G. M. T., | 22 7 25 00 | R. A. M. S., $7^h$ $25^m$, | 2 01 54 .34 | L. S. T., | 4 01 54.34 |

Example: April 22, 1879, in Long. 75° E., the local mean time is $4^h.00^m.00^s$ a. m. Required the local sidereal time.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| L. M. T., | $21^d$ $16^h$ $00^m$ $00^s$ | R. A. M. S. $21^d$ $0^h$, | $1^h$ $56^m$ $44^s.69$ | L. M. T., | $21^d$ $16^h$ $00^m$ $00^s$ |
| Long., − | 5 00 00 | Red. for $11^h$ (Tab. 9), + | 1 48 .42 | R. A. M. S., + | 1 58 33.11 |
| G. M. T., | 21 11 00 00 | R. A. M. S., $11^h$, | 1 58 33 .11 | L. S. T., | 21 17 58 33.11 |

In these examples the reduction of the R. A. M. S. has formed a separate operation in order to make clear the process. It would be as accurate to add together directly L. M. T., R. A. M. S., and Red., and the work would thus be rendered more brief.

**291. To Convert Sidereal into Mean Solar Time.**—Take from the Nautical Almanac the Right Ascension of the Mean Sun for Greenwich mean noon of the given astronomical day, and apply to it the reduction for longitude, either by Table 9 or by the hourly difference of $9^s.857$, and the result will be the Right Ascension of the Mean Sun at local mean noon, which is equivalent to the local sidereal time at that instant. Subtract this from the given local sidereal time (adding $24^h$ to the latter if necessary), and the result will be the interval from local mean noon, expressed in units of sidereal time. Convert this sidereal time interval into a mean time interval by subtracting the reduction as given by Table 8 or by the hourly difference of $9^s.830$; the result will be the local mean time.

Example: April 22, 1879, a. m., in Long. 75° E., the local sidereal time is $17^h.58^m.33^s.11$. What is the local mean time?

Astronomical day, April 21.

| | | | |
|---|---|---|---|
| L. S. T., | $17^h$ $58^m$ $33^s.11$ | R. A. M. S., Gr. $21^d$ $0^h$, | $1^h$ $56^m$ $44^s.69$ |
| R. A M. S., | − 1 55 55 .41 | Red. for −$5^h$ long. (Tab. 9), − | 49 .28 |
| Sid. interval from L. M. noon, | 16 02 37 .70 | R. A. M. S., local $0^h$, | 1 55 55 .41 |
| Red. for sid. interval (Tab. 8), | 2 37 .70 | | |
| L. M. T., $21^d$, | 16 00 00 .00 | | |

Example: April 22, 1879, p. m., at a place in Long. 81° 15′ W., the sidereal time is $4^h.01^m.54^s.34$. What is the corresponding mean time?

Astronomical day, April 22.

| | | | |
|---|---|---|---|
| L. S. T., | $4^h$ $01^m$ $54^s.34$ | R. A. M. S , Gr. $22^d$ $0^h$, | $2^h$ $00^m$ $41^s.24$ |
| R. A. M. S., | − 2 01 34 .63 | Red. for +$5^h$ $25^m$ long. (Tab. 9), + | 0 53 .39 |
| Sid. interval from L. M. Noon, | 2 00 19 .71 | R. A. M. S., local $0^h$, | 2 01 34 .63 |
| Red. for sid. interval (Tab. 8), − | 0 19 .71 | | |
| L. M. T., $22^d$, | 2 00 00 .00 | | |

**292. To Covert Mean into Apparent Time and the Reverse.**—Find the Greenwich time corresponding to the given local time. If apparent time is given, find the Greenwich apparent time and take the equation of time from Page I of the Almanac. If mean time, find the Greenwich mean time and take the equation of time from Page II. Correct the equation of time for the required instant and apply it with its proper sign to the given time.

Example: April 21, 1879, in Long. 81° 15′ W., find the local apparent time corresponding to a local mean time of $3^h.05^m.00^s$ p. m.

| | | | | | |
|---|---|---|---|---|---|
| L. M. T., | $21^d$ $3^h$ $05^m$ $00^s$ | L. M. T., | $21^d$ $3^h$ $05^m$ $00^s$ | Eq. t., $0^h$, | $1^m$ 17.61 |
| Long., + | 5 25 00 | Eq. t., + | 1 22.01 | Corr., + | 4.40 |
| G. M. T., | 21 8 30 00 | L. A. T., | 21 3 06 22.01 | Eq. t., | 1 22.01 |

| | |
|---|---|
| H. D., + | $0^s.518$ |
| G.M.T., + | $8^h.5$ |
| Corr., + | $4^s.403$ |

(*Add* to *mean* time.)

EXAMPLE: April 3, 1879, in Long. 81° 15′ E., the local apparent time is 8$^h$ 45$^m$ 00$^s$ a. m. Required the mean time.

| | | | | | |
|---|---|---|---|---|---|
| L. A. T., | 2$^d$ 20$^h$ 45$^m$ 00$^s$ | L. A. T., | 2$^d$ 20$^h$ 45$^m$ 00$^s$ | Eq. t., 0$^h$, | 3$^m$ 42$^s$.46 |
| Long., | — . 5 25 00 | Eq. t., + | 3 30.90 | Corr., | — 11 .56 |
| G. A. T., | 2 15 20 00 | L. M. T., | 2 20 48 30.90 | Eq. t., | 3 30 .90 |

| | | |
|---|---|---|
| H. D., | — | 0$^s$.754 |
| G. M. T., | — | 15$^h$.33 |
| Corr., | — | 11$^s$.56 |

(*Add* to apparent time.)

**293.** To FIND THE HOUR ANGLE OF A BODY FROM THE TIME, AND THE REVERSE.—In figure 36, if M and M′ represent the positions of celestial bodies instead of those of the mean sun as before assumed, then the hour angles of the bodies will be Q M and 24$^h$ — M′ Q, respectively, and their right ascensions will be V M and V M′.

As before, we have:

$$Q V = Q M + V M,$$
$$= V M′ — M′ Q;$$
$$Q M = Q V — V M;$$
$$M′ Q = V M′ — V Q, \text{ or}$$
$$(24^h — M′ Q) = (24^h + Q V) — V M′.$$

Substituting, therefore, *hour angle of the body* for *mean time*, and *right ascension of the body* for *Right Ascension of the Mean Sun*, the rules previously given for the conversion of mean and sidereal times will be applicable for the conversion of hour angle and sidereal time. Thus, the sidereal time is equal to the sum of the right ascension of the body and its hour angle, subtracting 24$^h$ when the sum exceeds that amount; and the hour angle equals the sidereal time *minus* the right ascension of the body, 24$^h$ being added to the former when necessary to render the subtraction possible.

EXAMPLE: In Long. 81° 15′ W., on April 25, 1879, at 12$^h$ 10$^m$ 30$^s$ (astronomical) mean time, find the hour angle of Sirius.

| | | | | |
|---|---|---|---|---|
| L. M. T., | 12$^h$ 10$^m$ 30$^s$ | L. M. T., | | 12$^h$ 10$^m$ 30$^s$ |
| Long., | + 5 25 00 | R. A. M. S., 0$^h$, + | 2 12 30.91 | |
| | | Red. (Tab. 9), + | 2 53.39 | |
| G. M. T., | 17 35 30 | | | |
| | | L. S. T., | | 14 25 54.30 |
| | | R. A. Sirius, — | 6 39 49.83 | |
| | | H. A. Sirius, | | 7 46 04.47 |

EXAMPLE: May 9, 1879, Arcturus being 2$^h$ 27$^m$ 42$^s$.52 east of the meridian, find the local sidereal time

| | | |
|---|---|---|
| | 24$^h$ 00$^m$ 00$^s$ | |
| H. A., | 2 27 42.52 E. | |
| H. A., | 21 32 17.48 W. | |

| | |
|---|---|
| H. A., | 21$^h$ 32$^m$ 17$^s$.48 |
| R. A., | + 14 10 11.71 |
| L. S. T., | 11 42 29 .19 |

Or thus:

| | |
|---|---|
| H. A., | — 2$^h$ 27$^m$ 42$^s$.52 |
| R. A., | + 14 10 11 .71 |
| L. S. T., | 11 42 29 .19 |

# CHAPTER X.

## CORRECTION OF OBSERVED ALTITUDES.

**294.** The *true altitude* of a heavenly body at any place on the earth's surface is the altitude of its center, as it would be measured by an observer at the center of the earth, above the plane passed through the center of the earth at right angles to the direction of the zenith.

The *observed altitude* of a heavenly body, as measured at sea, may be converted to the true altitude by the application of the following-named corrections: *Index Correction, Dip, Refraction, Parallax,* and *Semidiameter.* The corrections for parallax and semidiameter are of inappreciable magnitude in observations of the fixed stars, and with planets are so small that they need only be regarded in refined calculations. In observations with the artificial horizon there is no correction for dip.

For theoretical accuracy, the corrections should be applied in the order in which they are named, but in ordinary nautical practice the order of application makes no material difference, except in the case of the parallax of the moon as explained in article 306.

### INDEX CORRECTION.

**295.** This correction is fully explained in articles 249 and 250, Chapter VIII.

### REFRACTION.

**296.** It is known by various experiments that the rays of light deviate from their rectilinear course in passing obliquely from one medium into another of a different density; if the latter be more dense, the ray will be bent toward the perpendicular to the line of junction of the media; if less dense, it will be bent away from that perpendicular.

The ray of light before entering the second medium is called the *incident* ray; after it enters the second medium it is called the *refracted* ray, and the difference of direction of the two is called the *refraction.*



Fig. 37.

The rays of light from a heavenly body must pass through the atmosphere before reaching the eye of an observer upon the surface of the earth. The earth's atmosphere is not of a uniform density, but is most dense near the earth's surface, gradually decreasing in density toward its upper limit; hence the path of a ray of light, by passing from a rarer medium into one of continually increasing density becomes a curve, which is concave toward the earth. The last direction of the ray is that of a tangent to the curved path at the eye of the observer, and the difference of the direction of the ray before entering the atmosphere and this last direction constitutes the refraction.

**297.** To illustrate this, consider the earth's atmosphere as shown in figure 37; let SB be a ray from a star S, entering the atmosphere at B, and bent into the curve BA; then the apparent direction of the star is AS′, the tangent to the curve at the point A, the refraction being the angle between the lines BS and AS′. If CAZ is the vertical line of the observer, by a law of Optics the vertical plane of the observer which contains the tangent AS′ must also contain the whole curve BA and the incident ray BS. Hence refraction increases the apparent altitude of a star without affecting its azimuth.

At the zenith the refraction is nothing. The less the altitude the more obliquely the rays enter the atmosphere and the greater will be the refraction. At the horizon the refraction is the greatest.

**298.** The refraction for a mean state of the atmosphere (barometer 30$^{in}$, Fahr. thermometer 50°) is given in Table 20 A; the combined refraction and sun's parallax in Table 20 B; and the combined refraction and moon's parallax in Table 24.

Since the amount of the refraction depends upon the density of the atmosphere, and the density varies with the pressure and the temperature, which are indicated by the barometer and thermometer, the *true* refraction is found by applying to the mean refraction the corrections to be found in Tables 21 and 22; these are deduced from Bessel's formulæ, and are regarded as the most reliable tables constructed. It should be remembered, however, that under certain conditions of the atmosphere a very extraordinary deflection occurs in rays of light which reach the observer's eye from low altitudes
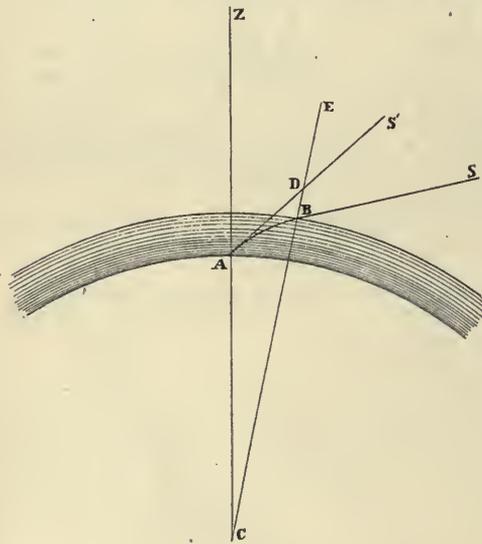
(that is, from points near the visible horizon), the amount of which is not covered by the ordinary corrections for pressure and temperature; the error thus created is discussed under *Dip* (art. 301); on account of it, altitudes less than 10° should be avoided.

EXAMPLE: Required the refraction for the apparent altitude 5°, when the thermometer is at 20° and the barometer at 30^{in} .67.

The mean refraction by Table 20 A is,　9′ 52″
The correction for height of barometer is, + 13
The correction for the temperature,　+ 42
　　　　　　　　　　　　　　　　　　　———
True refraction,　　　　　　　　　10 47

**299.** The correction for refraction should always be subtracted, as also that for combined refraction and parallax of the sun; the correction for combined refraction and parallax of the moon is invariably additive.

## DIP.

*Using sea for horizon*

**300.** *Dip of the Horizon* is the angle of depression of the visible sea horizon below the true horizon, due to the elevation of the eye of the observer above the level of the sea.

In figure 38 suppose A to be the position of an observer whose height above the level of the sea is AB. CAZ is the true vertical at the position of the observer, and AH is the direction of the true horizon, S being an observed heavenly body. Draw ATH′ tangent to the earth's surface at T. Disregarding refraction, T will be the most distant point visible from A. Owing to refraction, however, the most distant visible point of the earth's surface is more remote from the observer than the point T, and is to be found at a point T′, in figure 39. But to an observer at A the point T′ will appear to lie in the direction of AH″, the tangent at A to the curve AT′. If the vertical plane were revolved about CZ as an axis, the line AH would generate the plane of the true horizon, while the point T′ would generate a small circle of the terrestrial sphere called the *Visible* or *Sea Horizon*. The *Dip of the Horizon* is HAH″, being the angle between the true horizon and the apparent direction of the sea horizon. Values of the dip are given in Table 14 for various heights of the observer's eye, and in the calculation of the table allowance has been made for the effect of atmospheric refraction as it exists under normal conditions.
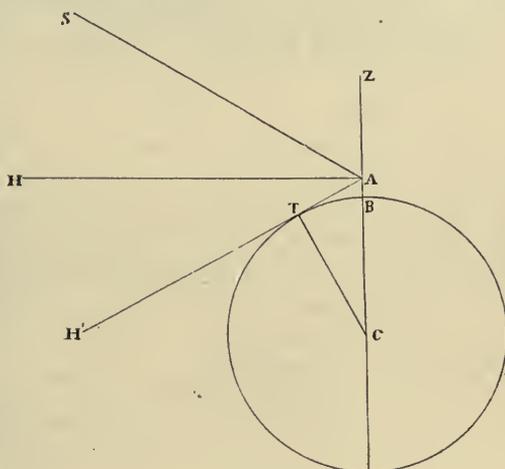


FIG. 38.
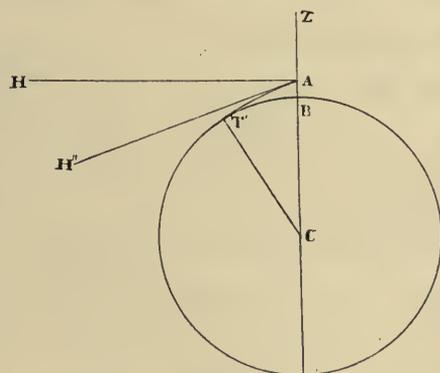


FIG. 39.

**301.** The fact must be emphasized, however, that under certain conditions the deflection of the ray in its path from the horizon to the eye is so irregular as to give a value of the dip widely different from that which is tabulated for the mean state of atmosphere. These irregularities usually occur when there exists a material difference between the temperature of the sea water and that of the air, and they attain a maximum value in calm or nearly calm weather, when the lack of circulation permits the air to arrange itself in a series of horizontal strata of different densities, the denser strata being below when the air is warmer, and the reverse condition obtaining when the air is cooler. The effect of such an arrangement is that a ray of light from the horizon, in passing through media of different densities, undergoes a refraction quite unlike that which occurs in the atmosphere of much more nearly homogeneous density that exists under normal conditions.

Various methods have been suggested for computing the amount of dip for different relative values of temperature of air and water, but none of these afford a satisfactory solution, there being so many elements involved which are not susceptible of determination by an observer on shipboard that it will always be difficult to arrive at results that may be depended upon. [a]

As the amount of difference between the actual and tabulated values of the dip due to this cause may sometimes be very considerable—reliable observations having frequently placed it above 10′, and values as high as 32′ having been recorded—it is necessary for the navigator to be on his guard against the errors thus produced, and to recognize the possible inaccuracy of all results derived from observations taken under unfavorable conditions. Without attempting to give any method for the determination of the amount of the extraordinary variation in dip, the following rules may indicate to the navigator the conditions under which caution must be observed, and the direction of probable error:

(a) A displacement of the horizon should always be suspected when there is a marked difference between the temperatures of air and sea water; this fact should be especially kept in mind in regions such as those of the Red Sea and the Gulf Stream, where the difference frequently exists.

---

[a] A sextant attachment devised by Lieutenant-Commander J. B. Blish, U. S. Navy, enables an observer to measure the actual dip at any time.

(*b*) The error in the tabulated value of the dip will increase with an increase in the difference of temperature, and will diminish with an increase in the force of the wind.

(*c*) The error will decrease with the height of the observer's eye; hence it is expedient, especially when error is suspected, to make the observation from the most elevated position available.

(*d*) When the sea water is colder than the air the visible horizon is raised and the dip is decreased; therefore the true altitude is greater than that given by the use of the ordinary dip table. When the water is warmer than the air, the horizon is depressed and the dip is increased. At such times the altitude is really less than that found from the use of the table.

The same cause, it may be mentioned here, affects the kindred matter of the visibility of objects. When the air is warmer, terrestrial objects are sighted from a greater distance and appear higher above the horizon than under ordinary conditions. When the water is warmer than the air, the distance of visibility is reduced, and terrestrial objects appear at a less altitude.

**302.** What has been said heretofore about the dip supposes the horizon to be free from all intervening land or other objects; but it often happens that an observation is required to be taken from a ship sailing along shore or at anchor in harbor, when the sun is over the land and the shore is nearer the ship than the visible sea-horizon would be if it were unconfined; in this case the dip will be different from that of Table 14, and will be greater the nearer the ship is to that point of the shore to which the sun's image is brought down. In such case Table 15 gives the dip at different heights of the eye and at different distances of the ship from the land.

**303.** The dip is always to be subtracted from the observed altitude.
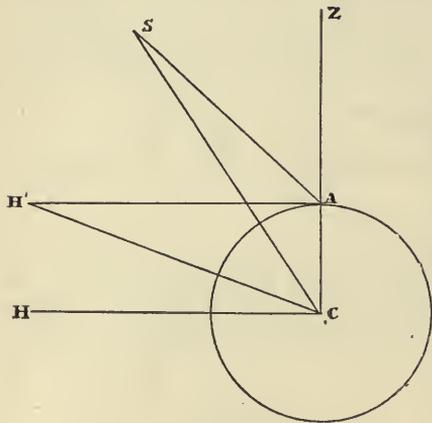


FIG. 40.

## PARALLAX.

**304.** The *parallax* of a heavenly body is, in general terms, the angle between two straight lines drawn to the body from different points. But in Nautical Astronomy *geocentric parallax* is alone considered, this being the difference between the positions of a heavenly body as seen at the same instant from the center of the earth and from a point on its surface.

The zenith distance of a body, S (fig. 40), seen from A, on the surface of the earth, is ZAS; seen from C it is ZCS; the *parallax* is the difference of these angles, ZAS−ZCS=ASC.

*Parallax in altitude* is, then, the angle at the heavenly body subtended by the radius of the earth.

If the heavenly body is in the horizon as at H′, the radius, being at right angles to AH′, subtends the greatest possible angle at the star for the same distance, and this angle is called the *horizontal parallax*. The parallax is less as the bodies are farther from the earth, as will be evident from the figure.

Let par. = parallax in altitude, ASC;
  Z = SAZ, the apparent zenith distance (corrected for refraction);
  R = AC, the radius of the earth; and
  D = CS, the distance of the object from the center of the earth.

Then, since SAC = 180° − SAZ, the triangle ASC gives:

$$\sin \text{ par.} = \frac{R \sin Z}{D}.$$

If the object is in the horizon at H′, the angle AH′C is the horizontal parallax, and denoting it by H. P. the right triangle AH′C gives:

$$\sin \text{H. P.} = \frac{R}{D}.$$

Substituting this value of $\frac{R}{D}$ in the above,

$$\sin \text{ par.} = \sin \text{H. P.} \sin Z.$$

If $h$ = SAH′, the apparent altitude of the heavenly body, then Z = 90° − $h$; hence,

$$\sin \text{ par.} = \sin \text{H. P.} \cos h.$$

Since par. and H. P. are always small, the sines are nearly proportional to the angles; hence,

$$\text{par.} = \text{H. P.} \cos h.$$

**305.** The Nautical Almanac gives the horizontal parallax of the moon, as well as of the planets Mercury, Venus, Mars, Jupiter, Saturn, Uranus, and Neptune.

In Table 16 will be found the values of the sun's parallax for altitude intervals of 5° or 10°, while Table 20 B contains the combined values of the sun's parallax and the refraction. In Table 24 is given the parallax of the moon, combined with the refraction, at various altitudes and for various values of the horizontal parallax.

**306.** Parallax is always additive; combined parallax and refraction additive in the case of the moon, but subtractive for the sun.

As the correction for parallax of the moon is so large, it is essential that it be taken from the table with considerable accuracy; the corrections for index correction, semidiameter, and dip should therefore be applied first, and the "approximate altitude" thus obtained should be used as an argument in entering Table 24 for parallax and refraction.

## SEMIDIAMETER.

**307.** The *semidiameter* of a heavenly body is half the angle subtended by the diameter of the visible disk at the eye of the observer. For the same body the semidiameter varies with the distance; thus, the difference of the sun's semidiameter at different times of the year is due to the change of the earth's distance from the sun; and similarly for the moon and the planets.

In the case of the moon, the earth's radius bears an appreciable and considerable ratio to the moon's distance from the center of the earth; hence the moon is materially nearer to an observer when in or near his zenith than when in or near his horizon, and therefore the semidiameter, besides having a menstrual change, has a semidiurnal one also.

The increase of the moon's semidiameter due to increase of altitude is called its *augmentation*. This reduction may be taken from Table 18.

The semidiameters of the sun, moon, and planets are given in their appropriate places in the Nautical Almanac.

**308.** The semidiameter is to be added to the observed altitude in case the lower limb of the body is brought into contact with the horizon, and to be subtracted in the case of the upper limb. When the artificial horizon is used, the limb of the *reflected* image is that which determines the sign of this correction, it being additive for the lower and subtractive for the upper.

EXAMPLE: May 6, 1879, the observed altitude of the sun's upper limb was 62° 10′ 40″; I. C., + 3′ 10″; height of the eye, 25 feet. Required the true altitude.

| | | | |
|---|---|---|---|
| Obs. alt. ☉, | 62° 10′ 40″ | I. C., | + 3′ 10″ |
| Corr., | — 18 04 | | |
| | | S. D. (Naut. Alm.), | — 15′ 53″ |
| True alt., | 61 52 36 | dip (Tab. 14), | — 4 54 |
| | | p. & r. (Tab. 20 B), | — 27 |
| | | | — 21 14 |
| | | Corr.. | — 18′ 04″ |

EXAMPLE: The altitude of Sirius as observed with an artificial horizon was 50° 59′ 30″; I. C., — 1′ 30″. Required the true altitude.

| | |
|---|---|
| Obs. 2 alt. ✳, | 50° 59′ 30″ |
| I. C., | — 1 30 |
| | 2)50 58 00 |
| Obs. alt., | 25 29 00 |
| ref. (Tab. 20 A), — | 2 02 |
| True alt., | 25 26 58 |

EXAMPLE: April 16, 1879, observed altitude of Venus 53° 26′ 10″; I. C., + 2′ 30″; height of eye, 20 feet. Required the true altitude.

| | | | | |
|---|---|---|---|---|
| Obs. alt. ✳, 53° 26′ 10″ | | par. (Tab. 17), | + 0′ 04″ | Hor. Par. (Naut. Alm.), 7″ |
| Corr., — | 2 32 | I. C., | + 2 30 | |
| | 53 23 38 | | + 2 34 | |
| | | dip (Tab. 14), | — 4′ 23″ | |
| | | ref. (Tab. 20 A), — | 43 | |
| | | | — 5 06 | |
| | | Corr., | — 2′ 32″ | |

EXAMPLE: May 6, 1879, at 13ʰ 24ᵐ G. M. T., the observed altitude of the moon's lower limb was 25° 30′ 30″; I. C., —1′ 30″; height of eye, 20 feet.   Required the true altitude.

| Obs. alt.☾, | 25° 30′ 30″ | S. D. (Naut. Alm.), | + 16′ 42″ | Hor. Par.(Naut. Alm.) 61′ 10″ |
|---|---|---|---|---|
| 1st corr., | +    10  57 | Aug. (Tab. 18), | +    08 | |
| Approx. alt., | 25  41  27 | | + 16  50 | |
| p. & r. (Tab. 24), + | 53  07 | | | |
| | | dip (Tab. 14), | —  4′ 23″ | |
| True alt., | 26  34  34 | I. C., | —  1  30 | |
| | | | —  5  53 | |
| | | 1st corr., | + 10′ 57″ | |

Or, the following modification may be adopted:

| Obs. alt.☾, | 25° 30′ 30″ | S. D., | + 16′ 42″ | H. P., | 3670″ | log 3.56467 |
|---|---|---|---|---|---|---|
| 1st corr., | +    8  56 | Aug., | +    08 | App. alt., 25° 39′ | | cos 9.95494 |
| Approx. alt., | 25  39  26 | | + 16  50 | | | |
| par., | +    55  08 | | | par., | { 3308″ | log 3.51961 |
| | | dip, | —  4′ 23″ | | { 55′ 08″ | |
| True alt., | 26  34  34 | ref., | —  2  01 | | | |
| | | I. C., | —  1  30 | | | |
| | | | —  7  54 | | | |
| | | 1st corr., + | 8′ 56″ | | | |

# CHAPTER XI.

## THE CHRONOMETER ERROR.

**309.** It has already been explained (art. 261, Chap. VIII) that the *error* of a chronometer is the difference between the time indicated by it and the correct standard time to which it is referred; and that the *daily rate* is the amount that it gains or loses each day. In practice, chronometer errors are usually stated with reference to Greenwich mean time. It is not required that either the error or the rate shall be zero, but in order to be enabled to determine the correct time it is essential that both rate and error be known, and that the rate shall have been uniform since its last determination.

**310.** DETERMINING THE RATE.—Since all chronometers are subject to some variation in rate under the changeable conditions existing on shipboard, it is desirable to ascertain a new rate as often as possible. The process of obtaining a rate involves the determination of the error on two different occasions separated by an interval of time of such length as may be convenient; the change of error during this interval, divided by the number of days, gives the daily rate.

EXAMPLE: On March 10, at noon, found chronometer No. 576 to be $0^m 32^s.5$ fast of G. M. T.; on March 20, at noon, the same chronometer was $0^m 48^s.0$ fast of G. M. T. What was the rate?

| | |
|---|---|
| Error, March $10^d 0^h$, | $+ 0^m 32^s. 5$ |
| Error, March $20^d 0^h$, | $+ 0 \quad 48 . 0$ |
| Change in 10 days, | $+ \quad 15 . 5$ |
| Daily rate, | $+ \quad 1^s.55$ |

The chronometer is therefore *gaining* $1^s.55$ per day.

**311.** DETERMINING ERROR FROM RATE.—The error on any given day being known, together with the daily rate, to find the error on any other day it is only necessary to multiply the rate by the number of days that may have elapsed, and to apply the product, with proper sign, to the given error.

EXAMPLE: On December 17 a chronometer is $3^m 27^s.5$ slow of G. M. T. and losing $0^s.47$ daily. What is the error on December 26?

| | | | |
|---|---|---|---|
| Error Dec. 17, $- 3^m 27^s.5$ | | Daily rate, $- 0^s.47$ | |
| Correction, $- \quad 4 .2$ | | No. days, $9$ | |
| Error Dec. 26, $- 3 \quad 31 .7$ | | Corr., $- 4 .23$ | |

The chronometer is therefore *slow* of G. M. T. on December 26, $3^m 31^s.7$.

**312.** It is necessary to distinguish between the signs of the chronometer *correction* and of the chronometer *error*. A chronometer fast of the standard time is considered as having a *positive error*, since its readings are positive to (greater than) those of an instrument showing correct time; but the same chronometer has a *negative correction*, as the amount must be subtracted to reduce chronometer readings to correct readings.

**313.** Numerous methods are available for determining the error of a chronometer in port. The principal of these will be given.

### BY TIME SIGNALS.

**314.** In nearly all of the important ports of the world a time signal is made each day at some defined instant. In many cases this consists in the dropping of a time-ball—the correct instant being given telegraphically from an observatory. In a number of places where there is no time-ball a signal may be received on the instruments at the telegraph offices, whereby mariners may ascertain the errors of their chronometers. Such signals are to be had in almost every port of the United States.

The time signal may be given by a gun-fire or other sound, in which case allowance must be made by the observer for the length of time necessary for the sound to travel from the point of origin to his position. Sound travels 1,090 feet per second at 32° F., and its velocity increases at the rate of 1.15 feet per second with each degree increase of temperature. If V be the velocity of sound in feet per second at the existing temperature, and D the distance in feet to be traversed, $\frac{D}{V}$ is the number of seconds to be subtracted from the chronometer reading at the instant of hearing the signal, to ascertain the reading at the instant the signal was made.

This method of obtaining the chronometer error consists in taking the difference between the standard time and chronometer time at the time of observation and marking the result with appropriate sign.

EXAMPLE: A time-ball drops at 5$^h$ 0$^m$ 0$^s$, G. M. T., and the reading of a chronometer at the same moment is 4$^h$ 57$^m$ 52$^s$.5.   What is the chronometer error?

|  |  |  |  |
|---|---|---|---|
| G. M. T., | 5$^h$ | 00$^m$ | 00$^s$ |
| Chro. t., | 4 | 57 | 52 .5 |
| Chro. error, — | | 2 | 07 .5 |

That is, chronometer *slow* 2$^m$ 07$^s$.5; chronometer *correction* additive.

## BY TRANSITS.

**315.** The most accurate method of finding the chronometer correction is by means of a transit instrument well adjusted in the meridian, noting the times of transit of a star or the limbs of the sun across the threads of the instrument.

At the instant of the body's passage over the meridian wire, mark the time by the chronometer. The hour angle at the instant is 0$^h$; therefore the local sidereal time is equal to the right ascension of the body in the case of a star, or the local apparent time is 0$^h$ in the case of the sun's center.   By converting this sidereal or apparent time into the corresponding mean time and applying the longitude, the Greenwich mean time of transit is given.   By comparing with this the time shown by chronometer the error is found.

EXAMPLE: 1879, May 9 (Ast. day), in Long. 44° 39′ E., observed the transit of Arcturus over the middle wire of the telescope, the time noted by a chronometer regulated to Greenwich mean time being 8$^h$ 05$^m$ 33$^s$.5.   Required the error.

|  |  |  |  |
|---|---|---|---|
| L. S. T. (R. A. ✱), | 14$^h$ | 10$^m$ | 11$^s$.71 |
| Long., — | 2 | 58 | 36 |
| G. S. T., | 11 | 11 | 35 .71 |
| R. A. M. S., 9$^d$ 0$^h$, — | 3 | 07 | 42 .69 |
| Sid. int. from 0$^h$, | 8 | 03 | 53 .02 |
| Reduction (Tab. 8), — | | 1 | 19 .27 |
| G. M. T., | 8 | 02 | 33 .75 |
| Chro. t., | 8 | 05 | 33 .50 |
| Chro. fast, | | 2 | 59 .75 |

EXAMPLE: June 25, 1879, in Long. 60° E., observed the transit of both limbs of the sun over the meridian wire of the telescope, noting the times by a chronometer.   Find the error of the chronometer on G. M. T.

| | | | | | |
|---|---|---|---|---|---|
| Transit of western limb, | 8$^h$ | 04$^m$ | 02$^s$.5 | Eq. t., | 2$^m$ 16$^s$.72 |
| Transit of eastern limb, | 8 | 06 | 20 .0 | | |
| | | | | H. D., + 0$^s$.532 | |
| Chro. time, loc. app. noon, | 8 | 05 | 11 .25 | Long., — 4$^h$ | |
| L. A. T., loc. app. noon, | 0$^h$ | 00$^m$ | 00$^s$ | Corr., — 2$^s$.128 | |
| Eq. t., + | | 2 | 14 .59 | | |
| | | | | Eq. t., 2$^m$ 14$^s$.59 | |
| L. M. T., loc. app. noon, | 0 | 02 | 14 .59 | *Add* to *apparent* time. | |
| Long., — | 4 | 00 | 00 | | |
| G. M. T., loc. app. noon, | 8 | 02 | 14 .59 | | |
| Chro. time, loc. app. noon, | 8 | 05 | 11 .25 | | |
| Chro. fast, | | 2 | 56 .66 | | |

## BY A SINGLE ALTITUDE (TIME SIGHT).

**316.** The problem involved in this solution, by reason of its frequent application in determining the longitude at sea, is one of the most important ones in Nautical Astronomy.   It consists in finding the hour angle from given values of the altitude, latitude, and polar distance.   The hour angle thus obtained is converted by means of the longitude and equation of time in the case of the sun, or longitude and right ascension in the case of other celestial bodies, into Greenwich mean time; and this, compared with the chronometer time, gives the error.

**317.** It should be borne in mind that the most favorable position of the heavenly body for time observations is when near the prime vertical.   When exactly in the prime vertical a small error in the latitude produces no appreciable effect.   Therefore, if the latitude is uncertain, good results may be obtained by observing the sun or other body when bearing east or west.   If observations are made at the same or nearly the same altitude on each side of the meridian and the mean of the results is taken, various errors are eliminated of which it is otherwise impossible to take account, and a very accurate determination is thus afforded.

**318.** With a sextant and artificial horizon or good sea horizon, several altitudes of a body should be observed in quick succession, noting in each case the time as shown by a hack chronometer or comparing watch whose error upon the standard chronometer is known.   Condensing the observation into

a brief interval justifies the assumption that the altitude varies uniformly with the time. A very satisfactory method is to set the sextant in advance at definite intervals of altitude and note the time as contact is observed.

**319.** Correct the observed altitude for instrumental and other errors, reducing the apparent to the true altitude.

If the sun, the moon, or a planet is observed, the declination is to be taken from the Nautical Almanac for the time of the observation. If the chronometer correction is not approximately known and it is therefore impossible to determine the Greenwich mean time of observation with a fair degree of accuracy, the first hour angle found will be an approximate one; the declination corrected by this new value of the time will produce a more exact value of the hour angle, and the operation may be repeated until a sufficiently precise value is determined.

**320.** In figure 41 there are given:

AO = $h$, the altitude of the body O;

DO = $d$, the declination; and



FIG. 41.

QZ = L, the latitude of the place.

In the astronomical triangle POZ there may be found from the foregoing:

ZO = $z$, the zenith distance of the body, = $90° - h$;

PO = $p$, the polar distance, = $90° \pm d$; and

PZ = co-L, the co-latitude of the place, = $90° - $ L.

From this data it is required to find the angle OPZ, the hour angle of the body, = $t$. This is given by the formula:

$$\sin^2 \tfrac{1}{2} t = \frac{\cos \tfrac{1}{2} (h + L + p) \sin \tfrac{1}{2} (L + p - h)}{\cos L \sin p}.$$

If we let $s = \tfrac{1}{2} (h + L + p)$, this becomes:

$$\sin \tfrac{1}{2} t = \sqrt{\sec L \, \operatorname{cosec} p \, \cos s \sin (s - h)}.$$

The polar distance is obtained by adding the declination to 90° when of different name from the latitude and subtracting it from 90° when of the same name. Like latitude and altitude it is always positive.

If the sun is the body observed, the resulting hour angle is the local apparent time and is to be taken from the a. m. or p. m. column of Table 44 according as the altitude is observed in the forenoon or afternoon. If the moon, a star, or a planet be taken, the hour angle is always found in the p. m. column.

Local apparent time as deduced from an observation of the sun is converted to local mean time by the application of the equation of time; then, by adding the longitude if west, and subtracting it if east, the Greenwich mean time is obtained.

The hour angle of any other body, added to its right ascension when it is west of the meridian at observation or subtracted therefrom when east, gives the local sidereal time, which may be reduced to Greenwich sidereal time by the application of the longitude, and thence to Greenwich mean time by methods previously explained.

A comparison of the Greenwich mean time with the chronometer time of sight gives the error of the chronometer.

EXAMPLE: January 20, 1879, p. m., in Lat. 48° 41′ 00″ S., Long. 69° 03′ 00″ E., observed a series of altitudes of the sun with a sextant and artificial horizon; mean double altitude, 59° 03′ 10″, images approaching; mean of times by comparing watch, 4ʰ 40ᵐ 56ˢ; C—W, 7ʰ 23ᵐ 25ˢ; index correction, −1′ 30″; approximate chronometer correction, −0ᵐ 10ˢ. What was the exact chronometer error?

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W. T., | 4ʰ 40ᵐ 56ˢ | Obs. 2 alt. ☉, | 59° 03′ 10″ | Dec., | 20° 08′ 26″.6 S. | Eq. t., | 11ᵐ 14ˢ.60 |
| C—W, | 7  23  25 | I. C., | −  1  30 | | | | |
| | | | | H. D., + | 32″.5 | H. D., + | 0ˢ.74 |
| Chro. t., | 0. 04  21 | | 2)59  01  40 | G. M. T., | 0ʰ.07 | G. M. T., | 0ʰ.07 |
| App. C. C., − | 0  10 | | | Corr., + | 2″.275 | Corr., + | 0ˢ.052 |
| | | ☉ | 29  30  50 | | | | |
| App. G. M. T., | 0  04  11 | Corr., + | 14  43 | Dec., | 20° 08′ 24″.3 S. | Eq. t., | 11ᵐ 14ˢ.7 |
| | | | | $p$, | 69° 51′ 36″ | (Add to apparent | |
| | | | 29  45  33 | | | time.) | |
| | | S. D., + | 16′ 17″ | | | | |
| | | p. & r., − | 1′ 34″ | | | | |
| | | Corr., + | 14′ 43″ | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $h$ | 29° 45′ 33″ | | | | L. A. T., | 4ʰ | 29ᵐ 46ˢ.7 | |
| L | 48 41 00 | | sec | .18031 | Eq. t., | + | 11 14.7 | |
| $p$ | 69 51 36 | | cosec | .02740 | | | | |
| | | | | | L. M. T., | 4 | 41 01.4 | |
| | 2)148 18 09 | | | | Long., | −4 | 36 12.0 | |
| $s$ | 74 09 05 | | cos | 9.43631 | G. M. T., | 0 | 04 49.4 | |
| $s-h$ | 44 23 32 | | sin | 9.84483 | Chro. t., | 0 | 04 21.0 | |
| | | | | 2)19.48885 | Chro. slow, | 0 | 00 28.4 | |
| L. A. T., 4ʰ 29ᵐ 46ˢ.7 | | sin ½ $t$ | 9.74442 | | | | | |

EXAMPLE: May 18, 1879, p. m., in Lat. 8° 03′ 22″ S., Long. 34° 51′ 57″ W., observed a series of altitudes of the star Arcturus, east of the meridian, using artificial horizon; mean double altitude, 60° 10′; mean watch time, 6ʰ 50ᵐ 32ˢ; C—W, 2ʰ 20ᵐ 59ˢ.5; I. C., +2′ 00″. Find the true error of the chronometer.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| W. T., | 6ʰ 50ᵐ 32ˢ | | Obs. 2 alt. ✶, | | 60° 10′ 00″ | R. A. ✶, | | 14ʰ 10ᵐ 11ˢ.7 | |
| C—W, | 2 20 59.5 | | I. C., | + | 2 00 | | | | |
| | | | | | | Dec. ✶, | | 19° 48′ 33″.5 N. | |
| Chro. t., | 9 11 31.5 | | 2)60 12 00 | | | | | | |
| | | | | | 30 06 00 | $p$, | | 109° 48′ 34″ | |
| | | | ref., | — | 1 41 | | | | |
| | | | $h$, | | 30 04 19 | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $h$ | 30° 04′ 19″ | | | | R. A. ✶, | | 14ʰ 10ᵐ 11ˢ.7 | |
| L | 8 03 22 | | sec | .00431 | H. A., | — | 3 35 41 | |
| $p$ | 109 48 34 | | cosec | .02650 | | | | |
| | | | | | L. S. T., | | 10 34 30.7 | |
| | 2)147 56 15 | | | | Long., | + | 2 19 27.8 | |
| $s$ | 73 58 08 | | cos | 9.44116 | G. S. T., | | 12 53 58.5 | |
| $s-h$ | 43 53 49 | | sin | 9.84096 | R. A. M. S., 0ʰ, | — | 3 43 11.7 | |
| | | | | 2)19.31293 | Sid. int. from 0ʰ, | | 9 10 46.8 | |
| H. A. | 3ʰ 35ᵐ 41ˢ E. | | sin ½ $t$ | 9.65647 | Red. (Tab. 8), | — | 1 30.2 | |
| | | | | | G. M. T., | | 9 09 16.6 | |
| | | | | | Chro. t., | | 9 11 31.5 | |
| | | | | | Chro. fast, | | 2 14.9 | |

## BY EQUAL ALTITUDES.

**321.** The method of observing *equal altitudes* of the same body on opposite sides of the meridian is usually employed for accurate determinations of the chronometer error when the method of transits is not available.

In the case of a star, the mean of the two chronometer times corresponding to the equal altitudes is the chronometer time of transit; but in the case of the sun the mean of these times differs somewhat from the time of transit, since, in consequence of the change of the sun's declination between the observations, the equal altitudes do not occur at equal intervals before and after the transit.

The small correction necessary, when the sun is observed, to reduce the mean of the times to the time of transit is called the *equation of equal altitudes*.

**322.** EQUAL ALTITUDES OF THE SUN.[a]—On shore, at a place whose longitude is *accurately* known, and whose latitude is *approximately* known, observe, with an artificial horizon, the same altitude both before and after meridian passage, as near the prime vertical as convenient when the altitude is more than 10°, noting the times. In low latitudes the method of equal altitudes will often give very accurate results, even when the observations are quite near the meridian.

It is most convenient, as well as conducive to accuracy, to take the observations in series, setting the sextant in advance of the altitude and marking the time at the instant that the contact is observed; about five or seven sights may compose a series, and several series may be observed; with the images of the sun alternately approaching and separating; thus the mean of the results (working each series of sights separately) will eliminate various possible errors. Ten minutes of double altitude will usually be found a convenient interval for observing.

The sights may be taken on opposite sides of the meridian for either upper or lower transit. If at upper transit, the first altitudes are taken in the forenoon and the times recorded; then in the afternoon the times corresponding to the same altitudes are observed, the same altitude last taken in the morning being the first to come on in the afternoon; series taken with separating images in the forenoon should be observed with approaching images in the afternoon, and the reverse. If the time of lower transit is to be determined, the first set of sights is taken in the afternoon of one day and the second set in the forenoon of the next, care being taken as before to observe with images moving in opposite directions on opposite sides of the meridian.

---

a Chauvenet's method.

**323.** The mean of the a. m. times call the *A. M. Chronometer Time,* the mean of the p. m. times, the *P. M. Chronometer Time.* If, instead of noting the times by the chronometer, a watch is used (compared with the chronometer both before and after each observation), it will generally be found necessary to make an allowance for its gain or loss on the chronometer, so as to obtain the exact difference between the watch and chronometer at the instant of observation. The difference applied to the mean of the watch times gives the mean chronometer time the same as would have been found by employing the chronometer directly.

The half sum of the A. M. and P. M. Chronometer Times is the *Middle Chronometer Time;* the P. M. *minus* the A. M. time in the case of observations for upper transit, or the A. M. *minus* the P. M. time for lower transit, gives the *Elapsed Time.* Twelve hours should be added to the chronometer time at second observation in any case where the chronometer has passed XII^h during the interval between sights.

Take from the Nautical Almanac, page I, the sun's declination, the hourly difference of declination, and the equation of time, reducing each to the instant of local apparent noon by applying the differences due to the longitude.

Mark *north* latitude and declination +, *south* latitude and declination —.

Mark hourly difference of declination when *toward north* +, when *toward south* —.

Enter Table 37 with the elapsed time, and take out log A and log B, prefixing to each its proper sign as given in the table at the head of the page.

To log A add the logarithm of the hourly diff. (Table 42) and the log tangent of the latitude (Table 44). Prefix to each logarithm the sign of the quantity it represents, and to their sum the sign which results from the algebraic multiplication of the quantities. This sum is the logarithm (Table 42) of the number of seconds of time in the *first part* of equation of equal altitudes, to be marked + or —, like its logarithm.

To log B add the logarithm of the hourly diff. and the log tangent of the declination, marking the signs as before. The sum is the logarithm of the *second part* of the equation of equal altitudes, to be marked + or — like its logarithm.

Combine the two parts, having regard to signs, to obtain the *equation of equal altitudes;* apply this, with proper sign, to the Middle Chronometer Time and the result is the *Chronometer Time of Local Apparent Noon* or *Chronometer Time of Local Apparent Midnight,* according as observations were taken on opposite sides of the meridian at upper or at lower transit.

Apply the equation of time (adding when it is additive to mean time, otherwise subtracting); the result is the *Chronometer Time of Local Mean Noon,* or *Midnight,* which, if the chronometer is regulated to local time, will be 12^h 0^m 0^s when the chronometer is right, more than 12^h when fast, less than 12^h when slow.

If the chronometer is regulated to Greenwich time, apply the longitude (in time) to the chronometer time of mean noon (subtracting in west, adding in east longitude); the result will be more or less than 12^h, according as the chronometer is fast or slow.

EXAMPLE: April 13, 1879, at a place in Lat. 30° 25′ N., Long. 5^h 25^m 42^s W., observed the following equal altitudes of the sun with a sextant and artificial horizon, noting the times by a watch compared with a chronometer regulated to Greenwich mean time. What is the error of the chronometer?

| A. M. COMPARISONS. | | P. M. COMPARISONS. | | | | | |
|---|---|---|---|---|---|---|---|
| Chro., | 2^h 22^m 30^s | Chro., | 8^h 04^m 30^s | Dec., | 9° 00′ 54″.1 N. | H. D. (13th),+54″.40 | |
| Watch, | 8 52 02 | Watch, | 2 34 01 | | | H. D. (14th),+54 .03 | |
| | | | | H. D. at noon,+ 54″.32 | | | |
| C—W, | 5 30 28 | C—W, | 5 30 29 | Long., | + 5^h.43 | Diff., 24 hrs.,— 0 .37 | |
| Chro., | 2^h 56^m 30^s | Chro., | 8^h 33^m 30^s | Corr., | + {294″.96 / 4′55″.0 | Diff., 1 hr., —0″.015 | |
| Watch, | 9 26 02 | Watch, | 3 03 01 | | | Diff., 5^h.43, —0 .03 | |
| C—W, | 5 30 28 | C—W, | 5 30 29 | Dec., | 9° 05′ 49″ N. | H.D. at noon,+54″.32 | |

| | WATCH, A. M. | ALTS. | WATCH, P. M. | | | | |
|---|---|---|---|---|---|---|---|
| | 9^h 12^m 30^s | 91° 00′ | 2^h 45^m 45^s | | | | |
| | 12 55 | 10 | 45 20 | | | | |
| | 13 20 | 20 | 44 55 | Tab. 37 | log A(—)9.4445 | log B (+)9.3193 | |
| | 13 45 | 30 | 44 30 | H. D. +54″.32 log | (+)1.7350 | log (+)1.7350 | |
| | 14 10 | 40 | 44 05 | Lat. +30° 25′ tan | (+)9.7687 | d + 9°6′ tan (+)9.2045 | |
| Mean, W. T., A. M., | 9^h 13^m 20^s | Mean, W. T., P. M., | 2^h 44^m 55^s | 1st Part—8^s.88 log | (—)0.9482 | | |
| C—W, | + 5 30 28 | C—W, | + 5 30 29 | 2d Part+1.81 | | log (+)0.2588 | |
| A. M. Chro. T., | 2 43 48 | P. M. Chro. T., | 8 15 24 | Eq. eq.} —7 .07 | | | |
| P. M. Chro. T., | + 8 15 24 | A. M. Chro. T., | — 2 43 48 | alt. } | | | |
| | 2)10 59 12 | Elapsed Time, | 5 31 36 | | | | |
| Mid. Chro. T., | 5 29 36 | Eq. t., | 0^m 35^s.02 | | | | |
| Eq. eq. alt., | — 7.1 | H. D., | + 0^s.65 | | | | |
| Chro. t. L. A. Noon, | 5 29 28.9 | Long., | + 5^h.43 | | | | |
| Eq. t., | — 0 31.5 | Corr., | + 3^s.53 | | | | |
| Chro. t. L. M. Noon, | 5 28 57.4 | Eq. t., | 0^m 31^s.5 | | | | |
| Long., | — 5 25 42.0 | *(Minus* to *mean* time.) | | | | | |
| Chro. fast. | 0 03 15.4 | | | | | | |

**324.** A quicker method of solving the same problem[a] is available when results are not required to be accurate to the fraction of a second.

If $h'$ is the change of altitude in minutes of arc, due to the total change in declination in the time elapsed between sights (the latitude and hour angle remaining the same), and $t'$ the number of seconds it requires for the sun to change its altitude one minute of arc, then:

$$\text{Equation of equal altitudes} = \tfrac{1}{2} h' \times t'.$$

Table 25 gives the change of altitude of an object arising from a change of 100 seconds in declination at various altitudes, declinations, and latitudes. By multiplying the appropriate quantity taken from this table by the total change of declination between sights, dividing by 100, and converting the result from seconds to minutes of arc, $h'$ is found. It is marked with the sign indicated in the table.

By dividing the number of seconds of time between the first and last sights of one of the series by the number of minutes difference of altitude, we find $t'$. When the sights are taken on opposite sides of the upper meridian $t'$ is *minus;* for the lower meridian it is *plus.*

When the artificial horizon is used, if $t'$ is computed on a basis of the change of the *double* altitude, its value is only half of the true one and the second term of the equation becomes $h' \times t'$ instead of as given above.

The example given in illustration of the preceding method when worked by this method is as follows:

Change in declination between sights = H. D. × elapsed time = $54''.32 \times 5^{h}.53 = 300''.$
Change in altitude due to $100''$ declination (Tab. 25) $= +56''.$
$$h' = + \frac{56 \times 300}{100 \times 60} = + 2'.80.$$
$$t' = - \frac{2^{h}45^{m}45^{s} - 2^{h}44^{m}05^{s}}{91° \ 40' - 91° \ 00'} = - \frac{100^{s}}{40'} = -2^{s}.5.$$
Eq. equal alt. $= + 2.80 \times -2^{s}.5 = -7^{s}.00.$

**325.** If equal altitudes of a planet were observed, the correction due to change of declination could be computed as in the case of the sun. It is not ordinarily expedient to use a planet, however, for if night sights are to be taken facility of working would make it preferable to employ a fixed star.

On account of its rapid and excessive change of declination the moon would never be observed for equal altitudes.

**326.** EQUAL ALTITUDES OF A FIXED STAR.—In selecting stars for this observation, it is to be remarked that the nearer to the zenith the star passes the less may the elapsed time be; and when a star passes exactly through the zenith the two altitudes may be taken within a few minutes of each other. But, with the ordinary sextants, altitudes near 90° can not be taken with the artificial horizon, as the double altitude is then nearly 180°. A limit is thus placed upon the extreme altitude that it is practicable to observe.

The sextant should be set and the coincidences of the two images of the star awaited, as in the case of the sun's limb, and the times by chronometer or watch noted as usual.

**327.** Take the mean of the times before the meridian passage as the *A. M. Chronometer Time,* and the mean of those after the meridian passage as the *P. M. Chronometer Time.* The mean of these two (adding $12^{h}$ to the later one in case the chronometer has passed $\text{XII}^{h}$ in the interval between sights) is the *Chronometer Time of Star's Transit.* At the instant of transit the local sidereal time will equal the right ascension of the star in case of the upper transit, or it will equal the right ascension *plus* $12^{h}$ in case of the lower transit. By converting local sidereal into Greenwich sidereal and thence into Greenwich mean time in the usual way, the chronometer error is found.

EXAMPLE:—June 8, 1879, at Cape Town, Lat. 33° 56' S., Long. 18° 28' 40'' E., using sextant and artificial horizon, observed equal altitudes of star Antares before and after upper transit, as stated below. Required the chronometer error on Greenwich mean time.

| | CHRO. A. M. | ALTITUDES. | | CHRO. P. M. |
|---|---|---|---|---|
| | $7^{h}$ $32^{m}$ $10^{s}.5$ | 125° 30' | | $11^{h}$ $34^{m}$ $20^{s}.3$ |
| | 7 32 35.0 | 40 | | 11 33 56.0 |
| | 7 32 59.3 | 50 | | 11 33 32.0 |
| A. M. Chro. t., | 7 32 34.9 | | P. M. Chro. t., | 11 33 56.1 |
| P. M. Chro. t., | 11 33 56.1 | | | |
| | 2)19 06 31.0 | | L. S. T.(R. A. ✳), | $16^{h}$ $22^{m}$ $03^{s}.5$ |
| | | | Long., | — 1 13 54.7 |
| Chro. t. Transit, | 9 33 15.5 | | | |
| G. M. T. Transit, | 9 59 30.9 | | G. S. T., | 15 08 08.8 |
| | | | R. A. M. S., $0^{h}$, | — 5 05 59.4 |
| Chro. slow, | 26 15.4 | | | |
| | | | Sid. int. from $0^{h}$, | 10 02 09.4 |
| | | | Red. (Tab. 8), | — 1 38.5 |
| | | | G. M. T., | 10 00 30.9 |

---

[a] Suggested by Commander W. E. Sewell, U. S. Navy.

**328.** Degree of Dependence.—An error of 5′ in the latitude would not affect the corresponding part of the equation of equal altitudes by more than one-hundredth of its amount in the most unfavorable case, and in general would have no sensible effect. It is one of the advantages of the equal altitude method, therefore, that it does not require an accurate knowledge of the latitude. It is also plain that errors in the longitude affecting the declination and its hourly difference produce but small proportionate effects upon the computed equation. The absolute error of the chronometer on Greenwich will be affected by the whole error in the longitude, but the *rate* will still be correct. Hence, we conclude that by this method the chronometer may be accurately *rated* at a place whose latitude and longitude are both imperfectly known.

The chief source of error is in the observation itself. The best observers with the sextant can not depend on the noted time of a *single* contact within $0^s.5$, and hence the intervals between the successive chronometer times (which, if observations could be perfectly taken, would be sensibly equal) may differ $2^s$. But the greatest probable error of the chronometer time of sun's or star's transit, from the mean of six such observations on each side of the meridian, is found to be not more than $0^s.2$, provided the rate of the chronometer between the observations is uniform.

# CHAPTER XII.

## LATITUDE.

### BY MERIDIAN ALTITUDE.

**329.** The latitude of a place on the surface of the earth, being its angular distance from the equator, is measured by an arc of the meridian between the zenith and the equator; hence, if the zenith distance of any heavenly body when on the meridian be known, together with the declination of the body, the latitude can thence be found.

Let figure 42 represent a projection of the celestial sphere on the plane of the meridian NZS; C, the center of the sphere; NS, the horizon; P and P', the poles of the sphere; QCQ', the equator; Z, the zenith of the observer. Then, by the above definition, ZQ will be the latitude of the observer; and NP, the altitude of the elevated pole, will also equal the latitude.

Let A be the position of a heavenly body north of the equator, but south of the zenith; QA = d, its declination; AS = h, its altitude; and ZA = z = 90° − h, its zenith distance.

From the figure we have:

$$QZ = QA + AZ, \text{ or}$$
$$L = d + z.$$



FIG. 42.

By attending to the names of $z$ and $d$, marking the zenith distance north or south according as the zenith is north or south of the body, the above equation may be considered general for any position of the body at upper transit, as A, A', A''.

In case the body is below the pole, as at A'''—that is, at its lower culmination—the same formula may be used by substituting 180° − $d$ for $d$. Another solution is given in this case by observing that:

$$NP = PA''' + NA''', \text{ or}$$
$$L = p + h.$$

**330.** A common practice at sea is to commence observing the altitude of the sun's lower limb above the sea horizon about 10 minutes before noon, and then, by moving the tangent-screw, to follow the sun as long as it rises; as soon as the highest altitude is reached, the sun begins to fall and the lower limb will appear to *dip*. When the sun dips the reading of the limb is taken, and this is regarded as the meridian observation.

It will, however, be found more convenient, and frequently more accurate, for the observer to have his watch set for the local apparent time of the prospective noon longitude, or to know the error of the watch thereon, and to regard as the *meridian* altitude that one which is observed when the watch indicates noon. This will save time and try the patience less, for when the sun transits at a low altitude it may remain "on a stand" without appreciable decrease of altitude for several minutes after noon; moreover, this method contributes to accuracy, for when the conditions are such that the motion in altitude due to change of hour angle is a slow one, the motion therein due to change of the observer's latitude may be very material, and thus have considerable influence on the time of the sun's dipping. This error is large enough to take account of in a fast-moving vessel making a course in which there is a good deal of northing or southing.

In observing the altitude of any other heavenly body than the sun, the watch time of transit should previously be computed and the meridian altitude taken by time rather than by the dip. This is especially important with the moon, whose rapid motion in declination may introduce still another element of inaccuracy.

**331.** The watch time of transit for the sun, or other heavenly body, may be found by the forms given below, knowing the prospective longitude, the chronometer error, and the amount that the watch is slow of the chronometer.

*For the Sun.*

| | | |
|---|---|---|
| L. A. T. noon, | | 0ʰ 00ᵐ 00ˢ |
| Long. (+ if west), | ± | _____ |
| G. A. T., | | |
| Eq. t., | ± | _____ |
| G. M. T., | | |
| C. C. (sign reversed), | ∓ | _____ |
| Chro. time, | | |
| C−W, | − | _____ |
| Watch time noon, | | |

*For other Bodies.*

| | | h    m    s |
|---|---|---|
| L. S. T. transit, | | (Right ascension.) |
| Long. (+ if west), | ± | _____ |
| G. S. T., | | |
| R. A. M. S., 0ʰ, | − | _____ |
| Sid int. from 0ʰ, | | |
| Red. (Tab. 8), | − | _____ |
| G. M. T., | | |
| C. C. (sign reversed), | ∓ | _____ |
| Chro. time, | | |
| C−W, | − | _____ |
| Watch time transit, | | |

**332.** From the observed altitude deduce the true altitude, and thence the true zenith distance. Mark the zenith distance North if the zenith is north of the body when on the meridian, South it the zenith is south of the body.

Take out the declination of the body from the Nautical Almanac for the time of meridian passage, having regard for its proper sign or name.

The algebraic sum of the declination and zenith distance will be the latitude. Therefore, add together the zenith distance and the declination if they are of the same name, but take their difference if of opposite names; this sum or difference will be the latitude, which will be of the same name as the greater.

EXAMPLE: At sea, June 21, 1879, in Long. 60° W., the observed meridian altitude of the sun's lower limb was 40° 4′; sun bearing south; I. C., +3′ 0″; height of the eye, 20 feet; required the latitude.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Obs. alt., | 40° 04′ 00″ | | S. D., | + 15′ 46″ | Dec., | 23° 27′ 20″.5 N. | *at G.A. noon.* |
| Corr., | + 13 21 | | I. C., | + 3 00 | | | |
| | ——— | | | ——— | H. D., + | 0″.32 | |
| h, | 40 17 21 | | | + 18 46 | Long., | 4ʰ. | |
| | | | | | | ——— | |
| z, | 49° 42′ 39″ N. | | dip, | − 4′ 23″ | Corr., + | 1″.28 | |
| d, | 23 27 22 N. | | p. & r., | − 1 02 | | ——— | |
| | ——— | | | ——— | Dec., | 23° 27′ 22″ | |
| L, | 73 10 01 N. | | | − 5 25 | | | |

Corr., + 13′ 21″

EXAMPLE: At sea, April 14, 1879, in Long. 140° E., the observed meridian altitude of the sun's lower limb was 81° 15′ 30″; sun bearing north; I. C.,−2′ 30″; height of the eye, 20 feet.

| | | | | | | |
|---|---|---|---|---|---|---|
| Obs. alt., | 81° 15′ 30″ | S. D., | + 15′ 59″ | Dec., | 9° 22′ 35″.4 N. | |
| Corr., | + 8 59 | | ——— | | | |
| | ——— | dip, | − 4 23 | H. D., + | 54″.03 | |
| h, | 81 24 29 | p. & r., | − 0 07 | Long., − | 9ʰ.33 | |
| | ——— | I. C., | − 2 30 | | ——— | |
| z, | 8° 35′ 31″ S. | | ——— | Corr., − | { 504″.1 | |
| d, | 9 14 11 N. | | − 7 00 | | { 8′ 24″.1 | |
| | ——— | | | Dec., | 9° 14′ 11″ N. | |
| L, | 0 38 40 N. | Corr., | + 8′ 59″ | | | |

EXAMPLE: At sea, May 15, 1879, Long. 0°, the observed meridian altitude of the sun's lower limb was 30° 13′ 10″; sun bearing north; I. C., +1′ 30″; height of the eye, 15 feet.

| | | | | | |
|---|---|---|---|---|---|
| Obs. alt., | 30° 13′ 10″ | S. D., | + 15′ 51″ | Dec., Gr. 0ʰ, 18° 50′ 48″.5 N. | |
| Corr., | + 12 02 | I. C., | + 1 30 | | |
| | ——— | | ——— | | |
| h, | 30 25 12 | | + 17 21 | | |
| | ——— | | | | |
| z, | 59° 34′ 48″ S. | dip, | − 3′ 48″ | | |
| d, | 18 50 49 N. | p. & r., | − 1 31 | | |
| | ——— | | | | |
| L, | 40 43 59 S. | | − 5 19 | | |

Corr., + 12′ 02″

EXAMPLE: January 1, 1879, the observed meridian altitude of Sirius was 53° 23′ 40″, bearing south; I. C.,+5′ 0″; height of the eye, 17 feet.

| | | | | | |
|---|---|---|---|---|---|
| Obs. alt., | 53° 23′ 40″ | I. C., | + 5′ 00″ | Dec. ✳, 16° 33′ 04″ S. | |
| Corr., | + 15 | | ——— | | |
| | ——— | dip, | − 4′ 02″ | | |
| h, | 53 23 55 | ref., | − 43 | | |
| | ——— | | ——— | | |
| z, | 36° 36′ 05″ N. | | − 4 45 | | |
| d, | 16 33 04 S. | | ——— | | |
| | ——— | Corr., | + 0′ 15″ | | |
| L, | 20 03 01 N. | | | | |

EXAMPLE: June 13, 1879, in Long. 65° W., and in a high northern latitude, the meridian altitude of the sun's lower limb was 8° 16′ 10″, below the pole; height of the eye, 20 feet; I. C., 0′ 00″.
Greenwich apparent time of lower culmination, June 13, 16ʰ 20ᵐ ( = Long. +12ʰ).

| | | | | | | |
|---|---|---|---|---|---|---|
| Obs. alt., | 8° 16′ 10″ | S. D., | + 15′ 47″ | Dec., | 23° 13′ 03″.8 N. | |
| Corr., | + 5 12 | | ——— | | | |
| | ——— | dip, | − 4 23 | H. D., + | 8″.58 | |
| h, | 8 21 22 | p. & r., | − 6 12 | G. M. T., | 16ʰ .33 | |
| | ——— | | ——— | | ——— | |
| z, | 81° 38′ 38″ S. | | − 10 35 | Corr., + | { 140″.5 | |
| 180°−d, | 156 44 36 N. | | ——— | | { 2′ 20″.5 | |
| | ——— | Corr., | + 5 12 | | ——— | |
| | 75 05 58 N. | | | Dec., | 23° 15′ 24″ N. | |
| | *Alternative method.* | | | | | |
| h, | 8° 21′ 22″ | | | p, | 66° 44′ 36″ | |
| p, | 66 44 36 | | | | ——— | |
| | ——— | | | 180°−d, | 156 44′ 36″ | |
| L, | 75 05 58 N. | | | | | |

EXAMPLE: June 26, 1879, in Long. 80° W., the observed meridian altitude of the moon's upper limb was 59° 6′ 40″, bearing south; I. C., + 2′ 0″; height of the eye, 19 feet.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| h, 59° 18′ 00″ | Obs. alt., . | 59° 06′ 40″ | G. M. T., Gr. trans., | 5ʰ 27ᵐ.6 | Dec. (11ʰ), | 4° 51′ 36″.5 S. | |
| | | | Corr. for Long (Tab. 11), + | 11 .0 | | | |
| z, 30° 42′ 00″ N. | I. C., | + 2 00 | | | M. D., − | 15″.07 | |
| d, 4 51 06 S. | | | L. M. T., local trans., | 5 38 .0 | No. min., − | 2ᵐ.0 | |
| | S. D., | − 16′ 03″ | Long., | + 5 20 .0 | | | |
| L, 25 50 54 N. | Aug., | − 14 | | | Corr., + | 30″.1 | |
| | dip, | − 4 16 | G. M. T., local trans., | +10 58 .0 | | | |
| | | − 20 33 | | | Dec., | 4° 51′ 06″ S. | |
| | 1st Corr., | − 18′ 33″ | | | | | |
| | Approx. alt., | 58° 48′ 07″ | | | Hor. Par., | 58′ 46″.3 | |
| | p. & r. (Tab. 24), + | 29 53 | | | | | |
| | h, | 59 18 00 | | | | | |

EXAMPLE: At sea, September 16, 1879, in Long. 75° E., the observed meridian altitude of Jupiter was 51° 25′ 24″, bearing north; I. C., + 3′ 0″; height of the eye, 16 feet.

| | | | | | | |
|---|---|---|---|---|---|---|
| Obs. alt., 51° 25′ 24″ | par., + 0′ 01″ | I. C., + 3 00 | G. M. T., Gr. trans., | 10ʰ 49ᵐ.8 | Dec., | 10° 44′ 20″.5 S. |
| Corr., − 1 41 | | | Corr. for Long., + | 0 .9 | | |
| h, 51 23 43 | | + 3 01 | L. M. T., local trans., | 10 50 .7 | H. D., − | 6″.58 |
| | | | Long., | − 5 00 .0 | G. M. T., | 5ʰ.84 |
| z, 38° 36′ 17″ S. | dip, − 3′ 55″ | | G. M. T. local trans., | 5 50 .7 | Corr., − | 38″.43 |
| d, 10 44 59 S. | ref., − 47 | | | | | |
| | | − 4 42 | | | Dec., | 10° 44′ 59″ S. |
| L, 49 21 16 S. | | | | | H. P., | 2″.2 |
| | Corr., − 1′ 41″ | | | | par. (Tab. 17), | 1″ |

**333.** CONSTANT.—In working a meridian altitude, especially the daily noon observation of the sun, it is frequently a convenience to so arrange the terms of the problem that all computation, excepting the application of the observed altitude, is completed beforehand; then the ship's latitude will be known immediately after the sight has been taken, it being necessary only to add or subtract the altitude.

It is assumed that the noon longitude will be sufficiently accurately known in advance to enable the navigator to correct the declination; also the approximate meridian altitude to correct the parallax and refraction; if the latter is not known, it may readily be found from the declination and approximate latitude.

Generally speaking,

$$\text{Lat.} = \text{Zenith distance} + \text{Dec.,}$$
$$= 90° - \text{True alt.} + \text{Dec.,}$$
$$= 90° - (\text{Obs. alt.} + \text{Corr.}) + \text{Dec.,}$$
$$= (90° + \text{Dec.} - \text{Corr.}) - \text{Obs. alt.,}$$

in which the quantity (90° + Dec. − Corr.) may be termed a *Constant* for the meridian altitude of the day, as it remains the same regardless of what the observed altitude may prove to be. The constant having been worked up before the observation is made, the latitude will be known as soon as the observed altitude is applied.

To avoid the confusion that might arise from the necessity of combining the terms *algebraically* according to their different names, it may be convenient to divide the problem into four cases and lay down rules for the *arithmetical* combination of the terms, disregarding their respective names as follows:

*Case I.* Lat. and Dec. same name, Lat. greater, + 90° + Dec. − Corr. − Obs. alt.
*Case II.* Lat. and Dec. same name, Dec. greater, − 90° + Dec. + Corr. + Obs. alt.
*Case III.* Lat. and Dec. opposite names, + 90° − Dec. − Corr. − Obs. alt.
*Case IV.* Lat. and Dec. same name, lower transit, + 90° − Dec. + Corr. + Obs. alt.

The correctness of such an arrangement will become readily apparent from an inspection of figure 42. The assumption has been made that the correction to the observed altitude is positive; when this is not true the sign of the correction must be reversed.

As examples of this method, the first, second, third, and fifth of the examples previously given illustrating the meridian altitude will be worked, using the constant; the details by which Corr. and Dec. are obtained are omitted, being the same as in the originals.

| 1ST EXAMPLE. | | 2D EXAMPLE. | | 3D EXAMPLE. | | 5TH EXAMPLE. | |
|---|---|---|---|---|---|---|---|
| *Case I.* | | *Case II.* | | *Case III.* | | *Case IV.* | |
| + 90° 00′ 00″ | | −90° 00′ 00″ | | +90° 00′ 00″ | | +90° 00′ 00″ | |
| Dec., | + 23 27 22 | Dec., | + 9 14 11 | Dec., | −18 50 49 | Dec., | −23 15 24 |
| Corr., | − 13 21 | Corr., | + 8 59 | Corr., | − 12 02 | Corr., | + 5 12 |
| Constant, | +113 14 01 | Constant, | −80 36 50 | Constant, | +70 57 09 | Constant, | +66 49 48 |
| Obs. alt., | − 40 04 00 | Obs. alt., | +81 15 30 | Obs. alt., | −30 13 10 | Obs. alt., | + 8 16 10 |
| Lat., | 73 10 01 (N.) | Lat., | 0 38 40 (N.) | Lat., | 40 43 59 (S.) | Lat., | 75 05 58 (N.) |

## BY REDUCTION TO THE MERIDIAN.

**334.** Should the meridian observation be lost, owing to clouds or for other reason, altitudes may be taken near the meridian and the times noted by a watch compared with the chronometer, from which, knowing the longitude, the hour angle may be deduced.

If the observations are within $26^m$ from the meridian, before or after, the correction to be applied to the observed altitude to reduce it to the meridian altitude may be found by inspection of Tables 26 and 27. Table 26 contains the variation of the altitude for one minute from the meridian, expressed in seconds and tenths of a second. Table 27 contains the product obtained by multiplying the square of the minutes and seconds by the change of altitude in one minute.

Let $a$ = change of altitude (in seconds of arc) in one minute from the meridian:

H = meridian altitude;

$h$ = corrected altitude at observation; and

$t$ = interval from meridian passage.

The value of the reduction to the meridian altitude of each altitude is found by the formula:

$$H = h + at^2,$$

$a$ being found in table 26, and $at^2$ in Table 27; hence the following rule:

Find the hour angle of the body in minutes and seconds of time. Take from Table 26 the value of $a$ corresponding to the declination and the latitude. Take from Table 27 the value of $at^2$ corresponding to the $a$ thus found and to the interval, in minutes and seconds, from meridian passage. This quantity will represent the amount necessary to reduce the corrected altitude at the time of observation to the corrected altitude at the meridian passage; it is always additive when the body is near upper transit, and always to be subtracted when near lower transit.

If the mean of a number of sights is to be taken, determine each reduction separately, take the mean of all the reductions, and apply it to the mean of the altitudes; it is incorrect, in such a case, to take the mean of the times and work the sight with this single value of $t$. The differences of altitude being small, the parallax and refraction will be sensibly the same for all, and one computation of the correction to the observed altitude will suffice.

Knowing the meridian altitude, the latitude is to be found as previously explained.

**335.** When several sights are taken, the most expeditious method of calculating will be to find first the watch time of transit, and thence obtain the hour angle of each observation by comparing the watch time of observation. The watch time of transit may be found as already explained (art. 331) for computing that quantity as a guide in taking the meridian altitude, but the hour angle thus obtained is subject to a correction. The difference between watch time of transit and watch time of observation gives the watch time—that is, the mean time—elapsing between transit and observation. A fixed star covers in that time an angle corresponding to the sidereal and not to the mean time interval, and a reduction should be made accordingly to give its true hour angle at the instant of observation. A planet's hour angle should be corrected in the same way (for we may disregard its very small change in right ascension). The correction may be entirely neglected in the case of the sun, as the difference between mean and apparent time intervals is immaterial. The reduction of the hour angle in the case of the moon becomes rather cumbersome, so much so that it is better to find the hour angle of this body by the more usual method of converting watch time to G. M. T., and thence to L. S. T., and finding the difference between the latter and the R. A.; an additional reason for this is that the G. M. T. of observation must be known exactly, with the moon, for the correction of the declination (art. 338).

**336.** Table 26 includes values of the latitude up to 60°, and those of the declination up to 63°, thus taking in all frequented waters of the globe and all heavenly bodies that the navigator is likely to employ. No values of $a$ are given when the altitudes are above 86° or below 6°, as the method of reduction to the meridian is not accurate when the body transits very near the zenith, and the altitudes themselves are questionable when very low. In case it is desired to find the change of altitude in one minute from noon for conditions not given in the tables, it may be computed by the formula:

$$a = \frac{1''.9635 \cos L \cos d}{\sin (L-d)}.$$

In working sights by this method where great accuracy is required, as in determining latitudes on shore for surveying purposes, it is well to compute the $a$ rather than to take it from the table, as one is thus enabled to employ the value as found to the second decimal place.

Due regard must be paid to the names of the declination and latitude in working this formula; if they are of opposite names, the declination is negative, and L and $d$ should be added together to obtain L—$d$.

**337.** Table 27 contains values of $at^2$ up to the limits within which the method is considered to apply with a fair degree of accuracy. It must not be understood that the plan of reduction to the meridian is not available for wider limits, but it would seem preferable to employ the $\varphi'$ $\varphi''$ formula, described hereafter, when the hour angle falls beyond that for which the table is computed. On the other hand, the reduction is not exact in all cases covered by the table; while sufficiently so for sea navigation, the limits given are far too wide for the precise determinations required in surveying, where the aim should be to observe bodies under such conditions that the total reduction $at^2$ shall not exceed 1'.

**338.** It should be kept clearly in mind when employing the method of reduction to the meridian that the resulting latitude is that of the ship at the instant of observation, and to bring it up to noon the run must be applied. The declination should properly be corrected for the instant of observation; with the sun or a planet, it is sufficiently accurate to use the declination at meridian passage, unless the interval from the meridian be quite large; but the moon's declination changes so rapidly that the exact time of observation must be used in its correction when working with this body.

EXAMPLE: In latitude 47° S., having previously worked up the constant for meridian altitude, 78° 42′ 10″, observed altitude of sun near meridian, 31° 11′ 50″; Dec. 11° N.; watch time, 11ʰ 40ᵐ 21ˢ, watch fast of L. A. T., 7ˢ. Find the latitude.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Watch time, | 11ʰ 40ᵐ 21ˢ | Obs. alt., | 31° 11′ 50″ | | $a$ (Tab. 26), | 1.″6 | |
| Watch fast, | 07 | $at^2$, | + 10 24 | | | | |
| L. A. T., | 11 40 14 | Mer. alt., | 31 22 14 | | | 1.″0 = | 6′ 30″ |
| | | Constant, | 78 42 10 | | $at^2$ (Tab. 27), | . 6 = | 3 54 |
| $t$, | 19ᵐ 46ˢ | | | | | 1. 6 = | 10 24 |
| | | Lat., | 47 19 56 S. | | | | |

EXAMPLE: At sea, July 12, 1879, in Lat. 50° N., Long. 40° W., observed circum-meridian altitude of the sun's lower limb, 61° 48′ 30″, the time by a chronometer regulated to Greenwich mean time being 2ʰ 41ᵐ 39ˢ; chro. corr., −2ᵐ 30ˢ; I. C., −3′ 0″; height of the eye, 15 feet. Find the latitude.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Chro. t., | 2ʰ 41ᵐ 39ˢ | ☉ | 61° 48′ 30″ | Dec., | 22° 00′ 23″.2 N. | | Eq. t., | 5ᵐ 17ˢ.99 | |
| C. C., − | 2 30 | Corr., + | 8 31 | | | | | | |
| | | | | H.D., − | 20″.7 | | H. D., + | 0ˢ.32 | |
| G.M.T., | 2 39 09 | $h$, | 61 57 01 | Long., | 2ʰ.7 | | Long., | 2ʰ.7 | |
| Eq. t., − | 5 19 | | | | | | | | |
| | | S. D., + | 15′ 46″ | Corr., − | 55″.9 | | Corr., + | .86 | |
| G. A. T., | 2 33 50 | | | | | | | | |
| Long., − | 2 40 00 | dip, − | 3 48 | Dec., | 21° 59′ 27″ N. | | Eq. t., | 5ᵐ 18ˢ.9 | |
| | | $p. \& r.$, − | 0 27 | | | | (Subtract from mean | | |
| L. A. T., | 11 53 50 | I. C., − | 3 00 | | | | time.) | | |
| | | | | | | | | | |
| $t$, | 6 10 | | − 7 15 | | | | | | |
| | | Corr., + | 8 31 | | | $a$ (Tab. 26), | 2.″5 | | |
| | | $h$, | 61° 57′ 01″ | | | | 2.″0 = | 1′ 16″ | |
| | | $at^2$, + | 1 35 | | | $at^2$ (Tab. 27), | 0. 5 = | 0 19 | |
| | | H, | 61 58 36 | | | | 2. 5 = | 1 35 | |
| | | $z$, | 28 01 24 N. | | | | | | |
| | | $d$, | 21 59 27 N. | | | | | | |
| | | L, | 50 00 51 N. | | | | | | |

EXAMPLE: May 31, 1879, in Lat. 30° 25′ N., Long. 5ʰ 25ᵐ 42ˢ W., about 9 p. m., observed with a sextant and artificial horizon a series of altitudes of Spica; mean observed double altitude 98° 06′ 34″; noted times as enumerated below by a watch compared with a chronometer which was 2ᵐ 33ˢ fast of G. M. T.; C—W, 5ʰ 29ᵐ 40ˢ; I. C., −3′ 00″. Find the latitude.

| | | | | | | |
|---|---|---|---|---|---|---|
| R. A. ✻ (L. S. T. transit), | 13ʰ 18ᵐ 52ˢ.2 | Mean 2 alt. ✻, | 98° 06′ 34″ | R. A. ✻, | 13ʰ 18ᵐ 52ˢ.2 | |
| Long., | + 5 25 42 | I. C., − | 3 00 | Dec., | 10° 32′ 04″ S. | |
| G. S. T., | 18 44 34 .2 | | 2)98 03 34 | | | |
| R. A. M. S. Gr. 0ʰ, | 4 34 26 .9 | | | $a$ (Tab. 26), | 2″.5 | |
| | | | 49 01 47 | | | |
| Sid. int. from 0ʰ, | 14 10 07 .3 | ref., − | 50 | | | |
| Red. (Tab. 8), | − 2 19 .4 | | | | | |
| | | $h$, | 49 00 57 | | | |
| G. M. T., | 14 07 47 .9 | | | | | |
| C. C. (sign reversed), | + 2 33 | | | | | |
| Chro. time transit, | 14 10 20 .9 | | | | | |
| C—W, | − 5 29 40 | | | | | |
| Watch time transit, | 8 40 41 | | | | | |

| Watch times. | Mean time. | Sid. time. | $at^2$ (Tab. 27). | | | $h$, | 49° 00′ 57″ |
|---|---|---|---|---|---|---|---|
| | | | 2.0 | 0.5 | 2.5 | $at^2$, + | 1 40 |
| 8ʰ 31ᵐ 18ˢ.0 | − 9ᵐ 23ˢ.0 | − 9ᵐ 24ˢ | 2′ 56″ | 0′ 44″ | 3′ 40″ | | |
| 33 19 .5 | 7 21.5 | 7 23 | 1 49 | 0 27 | 2 16 | H, | 49 02 37 |
| 36 07 .0 | 4 34 .0 | 4 35 | 0 42 | 0 10 | 0 52 | | |
| 38 50 .0 | 1 51 .0 | 1 51 | 0 07 | 0 01 | 0 08 | $z$, | 40 57 23 N. |
| 41 07 .5 | + 0 26 .5 | + 0 27 | 0 01 | 0 00 | 0 01 | $d$, | 10 32 04 S. |
| 43 45 .5 | 3 04 .5 | 3 05 | 0 19 | 0 04 | 0 23 | | |
| 45 46 .0 | 5 05 .0 | 5 06 | 0 52 | 0 13 | 1 05 | L, | 30 25 19 N. |
| 47 33 .0 | 6 52 .0 | 6 53 | 1 35 | 0 23 | 1 58 | | |
| 51 12 .5 | 10 31 .5 | 10 33 | 3 42 | 0 55 | 4 37 | | |

| | |
|---|---|
| | 9)15 00 |
| | 1 40 |

EXAMPLE: August 6, 1879, Lat. 59° S., Long. 175° 27′ E., during evening twilight, observed an altitude of Achernar, near lower transit, 26° 52′; watch time, 4ʰ 31ᵐ 12ˢ; C—W, 0ʰ 18ᵐ 07ˢ; chro. fast of G. M. T., 12ᵐ 42ˢ; I. C., +1′ 20′′; height of eye, 24 ft.   Find hour angle by both methods; thence the latitude.

| R. A. ✳ + 12ʰ | 13ʰ 33ᵐ 15ˢ.4 | | Watch time, | 4ʰ 31ᵐ 12ˢ |
| L. S. T. lower trans. | | | C—W, + | 0 18 07 |
| Long., − | 11 41 48 | | | |
| | | | Chro. t., | 4 49 19 |
| G. S. T., | 1 51 27.4 | | C. C., − | 12 42 |
| R. A. M. S. Gr. 5ᵈ 0ʰ, − | 8 54 39.8 | | | |
| | | | G. M. T. 5ᵈ, | 16 36 37 |
| Sid. int., | 16 56 47.6 | | R. A. M. S. Gr. 5ᵈ 0ʰ, + | 8 54 39.8 |
| Red. (Tab. 8), − | 2 46.6 | | Red. (Tab. 9), + | 2 43.7 |
| | | | | |
| G. M. T., | 16 54 01.0 | | G. S. T., | 1 34 00.5 |
| C. C. (sign reversed), + | 12 42 | | Long., + | 11 41 48 |
| | | | | |
| Chro. time, | 5 06 43 | | L. S. T., | 13 15 48.5 |
| C—W, − | 0 18 07 | | R. A. ✳ +12ʰ, | 13 33 15.4 |
| | | | | |
| Watch time transit, | 4 48 36 | | t, | 17 27 |
| Watch time obs., | 4 31 12 | | | |

t { Mean time,  17 24
    { Sid. time,  17 27

| Obs. alt. ✳, | 26° 52′ 00′′ | | R. A. ✳, | 1ʰ 33ᵐ 15ˢ.4 |
| I. C., + | 1′ 20′′ | | Dec., | 57° 50′ 28′′ S. |
| dip, − | 4′ 48′′ | | p, | 32° 09′ 32′′ |
| ref., − | 1 55 | | | |
| | 6 43 | | a (Tab. 26), | 0′′.6 |
| Corr., − | 5′ 23′′ | | at² (Tab. 27), | 3′.03′′ |
| h, | 26° 46′ 37′′ | | | |
| at², − | 3 03 | | | |
| H, | 26 43 34 | | | |
| p, | 32 09 32 | | | |
| L, | 58 53 06 S. | | | |

## BY A SINGLE ALTITUDE AT A GIVEN TIME.

**339.** This observation should be limited to conditions where the body is within three hours of meridian passage and where it is not more than 45° from the meridian in azimuth; also where the declination is at least 3°.  On the prime vertical the solution by this method is inexact, and when the hour angle is 6ʰ, or the declination 0°, it is impracticable.

The problem is: Given the hour angle, declination, and altitude, to find the latitude.  The solution is accomplished by letting fall, in the usual astronomical triangle, a perpendicular from the body to the meridian, and considering separately the distances on the meridian, from the pole and zenith, respectively, to the point of intersection of the perpendicular; the sum or difference of these distances is the co-latitude.

Following the usual designation of terms and introducing the auxiliaries $\varphi'$ and $\varphi''$, the formulæ are as follows:

$$\tan \varphi'' = \tan d \sec t;$$
$$\cos \varphi' = \sin h \sin \varphi'' \operatorname{cosec} d;$$
$$L = \varphi' + \varphi''.$$

The terms $\varphi'$ and $\varphi''$ will have different directions of application according to the position of the body relatively to the observer.  From a knowledge of the approximate latitude, the method of combining them will usually be apparent; it is better, however, to have a definite plan for so doing, and this may be based upon the following rule:

Mark $\varphi''$ north or south, according to the name of the declination; mark $\varphi'$ north or south, according to the name of the zenith distance, it being *north* if the body bears south and east or south and west, and *south* if the body bears north and east or north and west.  Then combine $\varphi''$ and $\varphi'$ according to their names; the result will be the latitude, except in the case of bodies near lower transit, when 180°−$\varphi''$ must be substituted for $\varphi''$ to obtain the latitude.

It may readily be noted that if we substitute $\varphi''$ for declination and $\varphi'$ for zenith distance, the problem takes the form of a meridian altitude; indeed, the method resolves itself into the finding of the zenith distance and declination of that point on the meridian at which the latter is intersected by a perpendicular let fall from the observed body.

The time should be noted at the instant of observation, from which is found the local time, and thence the hour angle of the celestial object.

If the sun is observed, the hour angle is the L. A. T. in the case of a p. m. sight, or $12^h$ - L. A. T. for an a. m. sight. If any other body, the hour angle may be found as hitherto explained.

EXAMPLE: June 7, 1879, in Lat. 30° 25′ N., Long. 81° 25′ 30″ W., by account; chro. time, $6^h$ $22^m$ $52^s$; obs. ☉ 75° 13′, bearing south and east; I. C. — 3′ 00″; height of the eye, 25 feet; chro. corr. — $2^m$ $36^s$. Find the latitude.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chro. t., | $6^h$ $22^m$ $52^s$ | Obs. alt. ☉, | 75° 13′ 00″ | Dec., | 22° 45′ 09″.9 N. | Eq. t., | $1^m$ 28$^s$.85 | |
| C. C., — | 2 36 | Corr., + | 7 40 | | | | | |
| | | | | H. D.. + | 14″.6 | H. D., — | 0$^s$.46 | |
| G. M. T., | 6 20 16 | $h$, | 75 20 40 | G. M. T., + | $6^h$.3 | G. M. T., + | $6^h$.3 | |
| Eq. t., + | 1 26 | | | | | | | |
| | | S. D., + | 15′ 48″ | Corr., {+ | 91″.98 | Corr., — | 2$^s$.85 | |
| G. A. T., . | 6 21 42 | | | {+ | 1′ 32″ | | | |
| Long., — | 5 25 42 | dip, — | 4′ 54″ | | | Eq. t., | $1^m$ 26$^s$. 0 | |
| | | p. & r., — | 14 | Dec., | 22° 46′ 42″ N. | (*Add* to *mean* time.) | | |
| L. A. T. = $t$, { $0^h$ $56^m$ 00$^s$ E. | | I. C., — | 3 00 | | | | | |
| { 14° 00′ 00″ | | | | | | | | |
| | | | — 8 08 | | | | | |
| | | Corr., + | 7′ 40″ | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $t$ | 14° 00′ 00″ | sec | .01310 | | | | |
| $d$ | 22 46 42 | tan | 9.62317 | cosec | .41210 | | |
| $h$ | 75 20 40 | | | sin | 9.98563 | | |
| $\varphi''$ | 23 24 07 N. | tan | 9.63627 | sin | 9.59898 | | |
| $\varphi'$ | 7 02 30 N. | | | cos | 9.99671 | | |
| Lat. | 30 26 37 N. | | | | | | |

EXAMPLE: May 28, 1879, p. m., in Lat. 6° 20′ S. by account, Long. 30° 21′ 30″ W.; chro. time, $7^h$ $35^m$ 10$^s$; observed altitude of moon's upper limb, 75° 33′ 00″, bearing north and east; I. C., — 3′ 00″; height of eye, 26 feet; chro. fast of G. M. T., $1^m$ 37$^s$.5. Required the latitude.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Chro. t., | $7^h$ $35^m$ 10$^s$ | Obs. alt. ☾, | 75° 33′ 00″ | R. A. ☾, | $10^h$ $21^m$ 07$^s$.78 | Dec., | 6°49′ 52″.4 N. |
| C. C., — | 1 37.5 | | | | | | |
| | | S. D., — | 15′ 51″ | M. D., + | 2$^s$.06 | M. D., — | 14″.46 |
| G. M. T., | 7 33 32.5 | Aug., — | 0 16 | No. min., | 33$^m$.54 | No. min., | 33$^m$.54 |
| R. A. M. S., + | 4 22 37.3 | dip, — | 5 00 | | | | |
| Red. (Tab. 9), + | 1 14.5 | I. C., — | 3 00 | Corr., + { | 69$^s$.09 | Corr., — { | 485″ |
| | | | | | 1$^m$ 09$^s$ | | 8′ 05″ |
| G. S. T., | 11 57 24.3 | 1st Corr., — | 24 07 | R. A., | $10^h$ $22^m$ 17$^s$ | Dec., | 6° 41′ 47″ N. |
| R. A. ☾, — | 10 22 17 | | | | | | |
| | | Approx. alt., | 75° 08′ 53″ | | | | |
| H. A. from Gr., | 1 35 07 W. | p. & r.(Tab. 24), + | 14 37 | | | | |
| Long., | 2 01 26 W. | $h$, | 75 23 30 | | | Hor. Par., | 58′ 03″ |
| $t$, { $0^h$ $26^m$ 19$^s$ E. | | | | | | | |
| { 6° 34′ 45″ | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| $t$ | 6° 34′ 45″ | sec | .00286 | | | |
| $d$ | 6 41 47 | tan | 9.06973 | cosec | .93324 | |
| $h$ | 75 23 30 | | | sin | 9.98573 | |
| $\varphi''$ | 6 44 26 N. | tan | 9.07259 | sin | 9.06959 | |
| $\varphi'$ | 13 05 40 S. | | | cos | 9.98856 | |
| Lat. | 6 21 14 S. | | | | | |

EXAMPLE: August 6, 1879, p. m., in Lat. 52° 47′ S. by D. R., Long. 146° 32′ E., observed altitude of Achernar, near lower transit, 24° 01′ 20″ bearing south and west; watch time, $6^h$ $48^m$ 22$^s$; C—W, $9^h$ $46^m$ 27$^s$; chro. corr. on G. M. T., + $1^m$ 57$^s$; height of eye, 18 feet; I. C. + 1′ 00″. Find the latitude.

| | | | | | |
|---|---|---|---|---|---|
| Watch time, | $6^h$ $48^m$ 22$^s$ | Obs. alt. ✳, 24° 01′ 20″ | | R. A. ✳, | $1^h$ $33^m$ 15$^s$.3 |
| C—W, + | 9 46 27 | Corr., — | 5 19 | | |
| | | | | Dec., | 57° 50′ 28″ S. |
| Chro. t., | 4 34 49 | $h$, | 23 56 01 | | |
| C. C., + | 1 57 | | | | |
| | | I. C., + | 1′ 00″ | | |
| G. M. T., 5$^d$, | 16 36 46 | | | | |
| R. A. M. S., + | 8 54 39.8 | dip, — | 4′ 09″ | | |
| Red. (Tab. 9), + | 2 43.7 | ref., — | 2 10 | | |
| | | | — 6 19 | | |
| G. S. T., | 1 34 09.5 | | | | |
| R. A. ✳, | 1 33 15.3 | | | | |
| | | Corr., — | 5′ 19″ | | |
| H. A. from Gr., | 0 00 54 W. | | | | |
| Long., | 9 46 08 E. | | | | |
| H. A., | 9 47 02 W. | | | | |
| { $2^h$ $12^m$ 58$^s$ | | | | | |
| { 33° 14′ 30″ | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| $t$ | 33° 14′ 30″ | sec | .07760 | | |
| $d$ | 57 50 28 | tan | .20153 | cosec | .07233 |
| | | | | | |
| $h$ | 23 56 01 | | | sin | 9.60818 |
| $180° - \varphi''$ | 117 44 18 S. | tan | .27913 | sin | 9.94699 |
| | | | | | |
| $\varphi'$ | 64 54 15 N. | | | cos | 9.62750 |
| | | | | | |
| Lat. | 52 50 03 S. | | | | |

## BY THE POLE STAR.

**340.** This method, confined to northern latitudes, is available when the star Polaris and the horizon are distinctly visible, the time of the observation being noted at the moment the altitude is measured.

Two methods will be given. The first is sufficiently precise for nautical purposes, involving the computation of the formula:

$$L = h - p \cos t,$$

in which,

$h =$ true altitude, deduced from the observed altitude;

$p =$ polar distance $= 90° - d$, the apparent declination being taken from the Nautical Almanac for the date;

$t =$ star's hour angle.

Find the right ascension and declination of Polaris from the Nautical Almanac; then find the hour angle in the usual way.

To the log cosine of the hour angle add the logarithm of the polar distance in minutes; the number corresponding to the resulting logarithm will be a correction in minutes to be subtracted from the star's true altitude to find the latitude.

Attention must be paid to the sign of the correction $p \cos t$. If $t$ is more than 6ʰ and less than 18ʰ, the sign of $\cos t$ is $-$; hence the formula becomes arithmetically:

$$L = h + p \cos t.$$

EXAMPLE: June 11, 1879, from an observed altitude of Polaris the true altitude was found to be 29° 5′ 55″. The time noted by a Greenwich chronometer was 13ʰ 41ᵐ 26ˢ; chro. corr. — 2ᵐ 22ˢ; Long. 5ʰ 25ᵐ 42ˢ W.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chro. time, | 13ʰ 41ᵐ 26ˢ | | $h$, | 29° 05′ 55″ | | R. A. ✳, | 1ʰ 14ᵐ 04ˢ | |
| C. C., | − 2 22 | | $p \cos t$, | + 1 19 54 | | | | |
| | | | | | | Dec., | 88° 39′ 47″ N. | |
| G. M. T., 11ᵈ, | 13 39 04 | | Lat., | 30 25 49 N. | | | | |
| R. A. M. S., | + 5 17 49 | | | | | | 1° 20′ 13″ | |
| Red. (Tab. 9), | + 2 15 | | | | | $p$, | 80′.2 | |
| | | | | | | $p$, 80′.2 | log | 1.90417 |
| G. S. T., | 18 59 08 | | | | | $t$, 175° 09′ 30″ | cos (−) | 9.99845 |
| R. A. ✳, | − 1 14 04 | | | | | | | |
| | | | | | | $p \cos t$, − | 79′.9 log (−) | 1.90262 |
| H. A. from Gr., | 17 45 04 W. | | | | | | 1° 19′ 54″ | |
| Long., | 5 25 42 W. | | | | | | | |
| | | | | | | | | |
| H. A., | 12 19 22 W. | | | | | | | |
| | | | | | | | | |
| $t$, | 11ʰ 40ᵐ 38ˢ E. | | | | | | | |
| | 175° 09′ 30″ | | | | | | | |

**341.** The second method is more rigorous, and should be employed when greater accuracy is sought. It is embodied in Table 28.

Reduce the observed altitude of the star to the true altitude. Find from the Nautical Almanac the apparent right ascension and declination of the star at the time of observation. Find the hour angle in the usual manner.

With the hour angle take out the *first correction*, A, from Table 28, giving to it the sign — when the hour angle is numerically less than 6ʰ; the sign + when the hour angle is greater than 6ʰ.

With the hour angle and altitude take out the *second correction*, B, from Table 28. The sign of this correction is always +. (If the altitude is greater than 60°, this correction may be found by taking that for 45° and multiplying it by the tangent of the altitude; adding, if desirable, the second term in the expression for B, viz: + 0″.0076 sin⁴ $t$ tan³ $h$.)

With B and the declination take out the *third correction*, C, from Table 28, giving it the sign + when the declination is less than 88° 48′; — when the declination is greater than 88° 48′.

With A and the declination take out the *fourth correction*, D, from Table 28, giving it the same sign as that of A when the declination is less than 88° 48′; the opposite sign when the declination is greater than 88° 48′.

Combine these corrections with the true altitude according to their signs; the result is the latitude of the place of observation.

If, when several sights are taken, great precision is required, or the intervals are great, it will be necessary to take out the *first* and *second* corrections for each observation separately; in other cases the

mean of the times may be used. The means of these two corrections may always be used for finding the *third* and *fourth* corrections; and these four quantities may be combined with the mean of the altitudes.

If the nearest 10″ suffices for each, the corrections may be taken out for the nearest arguments without interpolation, and all but the *first* may thus be taken out when a precision of 3″ is required. If a precision of 1′ is sufficient for each correction, as is ordinarily the case at sea, an hour angle within 3$^m$ will suffice for A; C and D may be neglected, and B used only when the altitude exceeds 47°.

EXAMPLE: January 1, 1903, about 9 p. m., Longitude 79° 54′ 07″ W., observed double altitude of Polaris with artificial horizon, 81° 57′ 20″; chro. time 1$^h$ 55$^m$ 12$^s$; chro. corr. on G. M. T. + 1$^m$ 07$^s$; I. C. − 0′ 50″. (The necessary quantities, taken from the Nautical Almanac for 1903, are given below.) Required the latitude.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chro. time, | | 1$^h$ | 55$^m$ | 12$^s$ | Obs. 2 alt. ✴, | | 81° | 57′ | 20″ | R. A. ✴, 1$^h$ 24$^m$ 33$^s$.3 |
| C. C., | + | | 1 | 07 | I. C., | − | | 0 | 50 | |
| | | | | | | | | | | Dec., 88° 47′ 42″ N. |
| G. M. T., | | 13 | 56 | 19 | | 2)81 | 56 | 30 | | |
| R. A. M. S., | +18 | 39 | 50.9 | | | 40 | 58 | 15 | | |
| Red. (Tab. 9), | + | 2 | 17.4 | | ref., | − − | | 1 | 07 | |
| G. S. T., | | 8 | 38 | 27.3 | | | | | | |
| R. A. ✴, | | 1 | 24 | 33.3 | h, | | 40 | 57 | 08 | |
| | | | | | A, | − | 1 | 03 | 13.9 | |
| H. A. from Gr., | | 7 | 13 | 54 W. | B, | + | | | 08.9 | |
| Long., | | 5 | 19 | 37 W. | C, | | | | 00.0 | |
| | | | | | D, | − | | | 15.7 | |
| H. A., | | 1 | 54 | 17 W. | Lat., | | 39 | 53 | 47 N. | |

# CHAPTER XIII.

## LONGITUDE.

**342.** The *longitude* of a position on the earth's surface is measured by the arc of the equator intercepted between the *prime meridian* and the meridian passing through the place, or by the angle at the pole between those two meridians.

*Meridians* are great circles of the terrestrial sphere passing through the poles.

The *prime meridian* is that one assumed as the origin, passing through the location of some principal observatory, such as Greenwich, Paris, or Washington. That of Greenwich is the prime meridian not only for English but also for American navigators, and those of many other nations.

*Secondary meridians* are those connected with the primary meridian, directly or indirectly, by exchange of telegraphic time signals.

*Tertiary meridians* are those connected with secondaries by carrying time in the most careful manner with all possible corrections.

Longitude is found by taking the difference between the hour angle of a celestial body from the prime meridian and its hour angle, at the same instant, from the local meridian. In determinations ashore the hour angle from the prime meridian may be found either from chronometers or from telegraphic signals; the local hour angle may be found by transit instruments or by sextant. In determinations at sea the chronometer and sextant give the only means available.

### DETERMINATION ASHORE.

**343.** TELEGRAPHIC DETERMINATION OF SECONDARY MERIDIANS.—In order to locate with accuracy the positions of prominent points on the coasts, it is necessary to refer them, by chronometric measurements, to secondary meridians of longitude which have been determined with the utmost degree of care.

Before the establishment of telegraphic cables, this was attempted principally through the observation of moon culminations, which seemed always to carry with them unavoidable errors, or by transporting to and fro a large number of chronometers between the principal observatory and the position to be located; and in this method it can be conceived that errors would be involved, no matter how thorough the theoretical compensation for error of the instruments.

By the aid of the electric telegraph, differences of longitude are determined with great accuracy, and an ever-increasing number of secondary meridional positions are thus established over the world; these afford the necessary bases in carrying on the surveys to map correctly the various coast lines, and render possible the publication of reliable and accurate navigators' charts.

**344.** To determine telegraphically the difference of longitude between two points, a small observatory containing a transit instrument, chronograph, break-circuit sidereal chronometer, and a set of telegraph instruments is established at each of the two points, and, being connected by a temporary wire with the cable or land line at each place, the two observatories are placed in telegraphic communication with each other.

By means of transit observations of stars, the error of the chronometer at each place on its own local sidereal time is well determined, and the chronometers are then accurately compared by signals sent first one way and then the other, the times of sending and receiving being very exactly noted at the respective stations. The error of each chronometer on local sidereal time being applied to its reading, the difference between the local times of the two places may be found, and consequently the difference of longitude. The time of transmission over the telegraph line is eliminated by sending signals both ways. By the employment of chronometers keeping sidereal time, the computation is simplified, though mean-time chronometers may be used.

**345.** ESTABLISHMENT OF TERTIARY MERIDIANS.—Let it be supposed that the meridional distance between A and B is to be measured, of which A is a *secondary* meridional position accurately determined, and B a *tertiary* meridional position to be determined.

If possible, two sets of observations should be taken at A to ascertain the errors and rates of the chronometers. The run is then made to B, and observations made to determine local time, and hence the difference of longitude; and on the same spot altitudes of the sun, or of a number of pairs of stars, or both, should be taken to determine the latitude.

Now, if chronometer rates could be relied on to be uniform, this measurement would suffice, but since variations may always arise, the run back to A should be made, or to another secondary meridional position, C, and new rates there obtained. Finally, the errors of the chronometers on the day when the observations were made at the tertiary position should be corrected for the loss or gain in rate, and for the difference of the errors as thus determined.

When opportunity does not permit obtaining a *rate* at the secondary meridional station or stations, both before and after the observations at B, the navigator may obtain the *errors* only, and assume that the rate has been uniform between those errors.

A modification of the foregoing method that may sometimes prove convenient is to make the first and third sets of observations at the position of the tertiary meridian, and the intermediate one at the secondary meridian; in this case the error will be obtained at the secondary station, and the rate at the tertiary.

EXAMPLE: A vessel at a station A, of known longitude, obtained chronometer errors as follows:

<div align="center">

May 27, noon, chro. slow, 7ᵐ 18ˢ.9,
June 3, noon, chro. slow, 7  12 .7;

</div>

then proceeding to a station B a series of observations for longitude was taken on June 17; after which, returning to A, the following errors were obtained:

<div align="center">

July  3, noon, chro. slow, 7ᵐ 00ˢ.7,
July 10, noon, chro. slow, 6  59 .8.

</div>

Required the correct error on June 17.

| | | | |
|---|---|---|---|
| May 27, | $-7^m\,18^s.9$ | July 3, | $-7^m\,00^s.7$ |
| June 3, | $-7\;\;12\,.7$ | July 10, | $-6\;\;59\,.8$ |
| Change, | $+\quad 6\,.2$ | Change, | $+\quad 0\,.9$ |
| Daily rate, | $+\quad 0^s.89$ | Daily rate, | $+\quad 0^s.13$ |

Therefore, assuming that these rates were correct at the middle of the periods for which they were determined, we have,

<div align="center">

May 30, Midnight, Rate,   $+0^s.89$
July  6, Midnight, Rate,   $+0\,.13$

Change of rate, 37 days,   $-0\,.76$

Daily change of rate,      $-0^s.021$

</div>

Change of rate for  3½ days, $-0^s.07$; rate June  3, noon, $+0^s.89-0^s.07=+0^s.82$
Change of rate for 17½ days, $-0^s.37$; rate June 17, noon, $+0\,.89-0\,.37=+0^s.52$

| | |
|---|---|
| Mean daily rate, June 3 to 17, | $+0\,.67$ |
| Total change of error, June 3 to 17, | $+0^m\,09^s.38$ |
| Error, June 3, | $-7\;\;12\,.7$ |
| Error, June 17, | $-7\;\;03\,.3$ |

**346.** SINGLE ALTITUDES.—The determination of longitudes ashore by single altitudes of a celestial body is identical in principle with the determination at sea by that method, which will be explained hereafter (art. 349). It may be remarked, however, that by taking observations on opposite sides of the meridian, at altitudes as nearly equal as possible, a means is afforded, which is not available at sea, of eliminating certain constant errors of observation.

**347.** EQUAL ALTITUDES.—The method of equal altitudes, explained in article 321, Chapter XI, is available for the determination of longitudes as well as for chronometer error. In the case of the sun, the sight gives the chronometer time of L. A. noon or midnight; applying the chronometer correction and equation of time (the latter with its sign for mean time), we obtain the G. A. T., which equals the longitude, if west, or 24ʰ *minus* the longitude, if east. For any other body, the sight gives the chronometer time of transit; apply the chronometer correction and there results G. M. T., which may be reduced to G. S. T.; the difference between the latter and the R. A. of the body (this being L. S. T.), is the longitude.

EXAMPLE: April 20 p. m. and April 21 a. m., 1879, in Lat. 30° 25′ N., Long. (approx.) 81° 26′ W., chro. corr. —3ᵐ 11ˢ.4, observed times and equal altitudes of the sun as stated below; C—W for p. m. sights, 5ʰ 31ᵐ 58ˢ.5, and for a. m. sights, 5ʰ 32ᵐ 01ˢ. Required the longitude.

| WATCH, P. M. | ALTS. | WATCH, A. M. | | | |
|---|---|---|---|---|---|
| 2ʰ 51ᵐ 40ˢ | 90° 0′ | 8ʰ 59ᵐ 00ˢ | Dec., | 11° 29′ 17″.1 N. | H. D. (20th), +51″.45 |
| 52  05 | 89  50 | 58  34 .5 | | | H. D. (21st), +50 .97 |
| 52  30 | 40 | 58  09 .5 | H. D. at Mid., + | 51″.10 | |
| 52  55 | 30 | 57  46 .0 | Long. +12ʰ, | 17ʰ.43 | Diff. 24ʰ, − 0 .48 |
| 53  20 | 20 | 57  20 .0 | | | |
| Mean, W. T., P.M., 2ʰ 52ᵐ 30ˢ.0 | Mean, W. T., A.M., 8ʰ 58ᵐ 10ˢ | | Corr., + { 890″.7 | Diff. 1ʰ, − 0″.02 |
| C − W, +5  31  58 .5 | C · W, + 5  32  01 | | { 14′ 51″ | |
| P. M. Chro. T., 8  24  28 .5 | A.M.Chro. T.+12ʰ, 26  30  11 .0 | | Dec., 11° 44′ 08″ N. | Diff. 17ʰ.43, − 0″.35 |
| A. M.Chro., T.+12ʰ,26  30  11 .0 | P. M. Chro. T., 8  24  28 .5 | | | H. D. at Mid., +51″.10 |
| 2)10  54  39 .5 | Elapsed Time, 18  05  42 .5 | | | |

<table>
<tr><td>Mid. Chro. T., 5 27 19 .75</td><td></td><td>Tab. 37</td><td>log A (+)9.9364</td><td>log B(−)9.7912</td></tr>
<tr><td>Eq. eq. alt., +  19 .35</td><td>Eq. t., 1ᵐ 04ˢ.9</td><td>H. D.+51″.10 log (+)1.7084</td><td>log (+)1.7084</td></tr>
<tr><td></td><td></td><td>Lat. 30° 25′ tan (+)9.7687</td><td>d +11° 44′ tan (+)9.3175</td></tr>
<tr><td>Chro. t., L. A. Mid., 5 27 39 .1</td><td>H. D., + 0ˢ.54</td><td>1st Part +25ˢ.91 log(+)1.4135</td><td></td></tr>
<tr><td>Eq. t., + 1 14 .3</td><td>Long. +12ʰ, 17ʰ.43</td><td>2d Part − 6 .56</td><td>log (−)0.8171</td></tr>
<tr><td>Chro. t., L. M. Mid., 5 28 53 .4</td><td>Corr., + 9ˢ.4</td><td></td><td></td></tr>
<tr><td>C. C., − 3 11 .4</td><td></td><td>Eq. eq. } +19 .35<br>alt., }</td><td></td></tr>
<tr><td></td><td>Eq. t., 1ᵐ 14ˢ.3</td><td></td><td></td></tr>
<tr><td>Long., W., { 5ʰ 25ᵐ 42ˢ.0<br>{ 81° 25′ 30″</td><td>(*Plus* to *mean* time.)</td><td></td><td></td></tr>
</table>

**348.** In the same example the equation of equal altitudes may be found by the less exact method heretofore given (art. 324), as follows:

Change in declination between sights = H. D. × Elapsed time = 51″.10 × 18ʰ.1 = 925″.

Change in altitude due to 100″ declination (Tab. 25) = + 53″.

$$h' = + \frac{53 \times 925}{100 \times 60} = + 8'.19.$$

$$t' = + \frac{2^h 53^m 20^s - 2^h 51^m 40^s}{90° 00' - 89° 20'} = + \frac{100^s}{40'} = + 2^s.5.$$

Eq. eq. alt. = + 8.19 × 2ˢ.5 = + 20ˢ.5.

## DETERMINATION AT SEA.

**349.** THE TIME SIGHT.—The method of determining longitude at sea which is employed almost to the exclusion of all others is that of the *time sight*, sometimes called the *chronometer method*. The altitude of the body above the sea horizon is measured with a sextant and the chronometer time noted; the hour angle of the body is then found by the process described in article 316, Chapter XI.

If the sun is observed, the hour angle is equal to the local apparent time; the Greenwich apparent time may be determined by applying the equation of time to the Greenwich mean time as shown by the chronometer; the longitude is then equal to the difference between the local and the Greenwich apparent times, being east when the local time is the later, and west when it is the earlier of the two.

If any other celestial body is employed, the hour angle from the local meridian, found from the sight, is compared with the hour angle from the Greenwich meridian to obtain the longitude; the Greenwich hour angle is found by converting the Greenwich mean time into Greenwich sidereal time in the usual manner, and then taking the difference between the latter and the right ascension of the body, the remainder being marked east or west, according as the Greenwich sidereal time is the lesser or greater of the two quantities; and as the local hour angle may be marked east or west according to the side of the meridian upon which it was observed, the name of the longitude will be indicated in combining the quantities.

**350.** As has been stated, the most favorable position of the celestial body for finding the hour angle from its altitude is when nearest the prime vertical, provided the altitude is not so small as to be seriously affected by refraction.

**351.** In determining the longitude at sea by this method, it is necessary to employ the latitude by account. This is seldom exactly correct, and a chance of error is therefore introduced in the resulting hour angle; the magnitude of such an error depends upon the position of the body relatively to the observer. The employment of the Sumner line, which is to be explained in a later chapter, insures the navigator against being misled from this cause, and its importance is to be estimated accordingly.

EXAMPLE: At sea, May 18, 1879, a. m.; Lat. 41° 33′ N.; Long. 33° 30′ W., by D. R., the following altitudes of the sun's lower limb were observed, and times noted by a watch compared with the Greenwich chronometer. Chro. corr., + 4ᵐ 59ˢ.2; I. C., — 30″; height of the eye, 23 feet; C — W, 2ʰ 17ᵐ 06ˢ. Required the true longitude.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| W. T., | 7ʰ 20ᵐ 15ˢ | | Obs. alt. ☉, | 29° 35′ 30″ | | Dec., | 19° 32′ 01″.8 N. | | Eq. t., | 3ᵐ 47ˢ.68 |
| | 20 47 | | | 41 20 | | | | | | |
| | 21 14 | | | 46 10 | | H. D., + | 33″.09 | | H. D., — | 0ˢ.09 |
| | | | | | | G. M. T., — | 2ʰ.3 | | G. M. T., — | 2ʰ.3 |
| Mean, | 7 20 45.3 | | Mean, | 29 41 00 | | | | | | |
| C — W, | + 2 17 06 | | Corr., + | 9 05 | | Corr., — {76″.1 ; 1′ 16″} | | | Corr., + | 0ˢ.21 |
| Chro. t., | 9 37 51.3 | | h, | 29 50 05 | | | | | Eq. t., | 3ᵐ 47ˢ.9 |
| C. C., + | 4 59.2 | | | | | Dec., | 19° 30′ 46″ N. | | | |
| | | | | | | | | | (*Plus* to *mean* time.) | |
| G. M. T., 17ᵈ, | 21 42 50.5 | | S. D., + | 15′ 51″ | | p, | 70° 29′ 14″ | | | |
| Eq. t., + | 3 47.9 | | dip, — | 4′ 42″ | | | | | | |
| | | | p. & r., — | 1 34 | | | | | | |
| G. A. T., | 21 46 38.4 | | I. C., — | 0 30 | | | | | | |
| | | | | — 6 46 | | | | | | |
| | | | Corr., + | 9′ 05″ | | | | | | |

|  | | | | |
|---|---|---|---|---|
| h | 29° 50′ 05″ | | | |
| L | 41 33 00 | | sec | .12588 |
| p | 70 29 14 | | cosec | .02569 |
| | 2)141 52 19 | | | |
| s | 70 56 09 | | cos | 9.51406 |
| s — h | 41 06 04 | | sin | 9.81782 |
| | | | | 2)19.48345 |
| G. A. T. | 21ʰ 46ᵐ 38ˢ | | | |
| L. A. T. | 19 32 07 | | sin ½ t | 9.74172 |
| Long. | {2ʰ 14ᵐ 31ˢ ; 33° 37′ 45″} W. | | | |

EXAMPLE: At sea, April 16, 1879, p. m., in Lat. 11° 47′ S., Long. 0° 20′ E., by D. R., observed an altitude of the star Aldebaran, west of the meridian, 23° 13′ 20″; chronometer time, 6ʰ 56ᵐ 32ˢ; chronometer fast of G. M. T., 2ᵐ 27ˢ; I. C. —2′ 00″; height of eye, 26 feet.   What was the longitude?

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Chro. t., | 6ʰ 56ᵐ 32ˢ | | Obs. alt. ✱, | 23° 13′ 20″ | | R. A. ✱, 4ʰ 28ᵐ 59ˢ. 6 | |
| C. C., | — 2 27 | | Corr., | — 9 16 | | | |
| G. M. T., | 6 54 05 | | h, | 23 04 04 | | Dec., 16° 15′ 59″ N. | |
| R. A. M. S., | +1 37 01.9 | | | | | p, 106° 15′ 59″ | |
| Red. (Tab. 9), | + 1 08.0 | | I. C., | — 2′ 00″ | | | |
| | | | dip, | — 5 00 | | | |
| G. S. T., | 8 32 14.9 | | ref., | — 2 16 | | | |
| R. A. ✱, | 4 28 59.6 | | | | | | |
| | | | Corr., | — 9 16 | | | |
| H. A. from Gr., | 4 03 15 W. | | | | | | |

|  | | | | |
|---|---|---|---|---|
| h | 23° 04′ 04″ | | | |
| L | 11 47 00 | | sec | .00925 |
| p | 106 15 59 | | cosec | .01774 |
| | 2)141 07 03 | | | |
| s | 70 33 32 | | cos | 9.52223 |
| s — h | 47 29 28 | | sin | 9.86757 |
| | | | | 2)19.41679 |

Gr. H. A. 4ʰ 03ᵐ 15ˢ W.
H. A.     4  05  50 W.      sin ½ t   9.70839

Long.   $\left\{ \begin{array}{c} 0^h\ 02^m\ 35^s \\ 0°\ 38′\ 45″ \end{array} \right\}$ E.

EXAMPLE: At sea, April 17, 1879, a. m., in Lat. 25° 12′ S., Long. 31° 32′ W., by D. R., observed an altitude of the planet Jupiter, east of the meridian, 45° 40′; watch time, 5ʰ 48ᵐ 02ˢ; C —W, 2ʰ 05ᵐ 42ˢ; C. C., +2ᵐ 18ˢ; I. C., +1′ 30″; height of eye, 18 feet.   Required the longitude.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W. T., | 5ʰ 48ᵐ 02ˢ | | Obs. alt. ✱, | 45° 40′ 00″ | R. A. (17ᵈ 0ʰ), | 22ʰ 27ᵐ 19ˢ.0 | Dec. (17ᵈ 0ʰ), 10° 36′ 28″.1 S. |
| C—W, | 2 05 42 | | Corr., | — 3 36 | H. D., | + 1ˢ.8 | H. D., + 10″.0 |
| Chro. t., | 7 53 44 | | h, | 45 36 24 | G. M. T., | — 4ʰ.1 | G. M. T., — 4ʰ.1 |
| C. C., | + 2 18 | | I. C., | + 1′ 30″ | Corr., | — 7ˢ.4 | Corr.. — 41″. |
| G. M. T., 16ᵈ, | 19 56 02 | | dip, | — 4′ 09″ | R. A., | 22ʰ 27ᵐ 11ˢ.6 | Dec., 10° 37′ 09″ S. |
| R. A. M. S., 0ʰ, | + 1 37 01.9 | | ref., | — 0 57 | | | p, 79° 22′ 51″ |
| Red. (Tab. 9), | + 3 16.5 | | | — 5 06 | | | |
| G. S. T., | 21 36 20.4 | | | | | | |
| R. A. ✱, | 22 27 11.6 | | Corr., | — 3′ 36″ | | | |
| H. A. from Gr., | 0 50 51 E. | | | | | | |

|  | | | | |
|---|---|---|---|---|
| h | 45° 36′ 24″ | | | |
| L | 25 12 00 | | sec | .04343 |
| p | 79 22 51 | | cosec | .00750 |
| | 2)150 11 15 | | | |
| s | 75 05 38 | | cos | 9.41032 |
| s — h | 29 29 14 | | sin | 9.69217 |
| | | | | 2)19.15342 |

Gr. H. A. 0ʰ 50ᵐ 51ˢ E.
H. A.     2  57  21 E.      sin ½ t   9.57671

Long.   $\left\{ \begin{array}{c} 2^h\ 06^m\ 30^s \\ 31°\ 37′\ 30″ \end{array} \right\}$ W.

EXAMPLE: At sea, June 26, 1879, p. m., in Lat. 49° 50′ N., Long. 6° 16′ W., by account, observed an altitude of the moon's lower limb 21° 18′ 10″, the body bearing east; chronometer time, 2ʰ 26ᵐ 58ˢ; chronometer slow of G. M. T., 42ˢ; I. C.,—1′ 45″; height of eye, 22 feet.   Find the longitude.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chro. t., | 2ʰ 26ᵐ 58ˢ | Obs. alt. ☾, | | 21° 18′ 10″ | R. A., | | 11ʰ 37ᵐ 41ˢ.96 | Dec., | 2° 35′ 36″.4 S. |
| C. C., | + 42 | S. D., | + | 15′ 59″ | M. D., + | 2ˢ.07 | M. D., − | 15″.1 |
| G. M. T., | 2 27 40 | Aug., | + | 6 | No. min., | 27ᵐ.7 . | No. min., | 27ᵐ.7 |
| R. A. M. S., | + 6 16 57.5 | | + | 16 05 | Corr., + | 57ˢ.34 | Corr., − { 419″.3 |
| Red. (Tab. 9), | + 0 24.3 | dip, | − | 4′ 36″ | R. A., | 11ʰ 38ᵐ 39ˢ.3 | 6′ 59″.3 |
| G. S. T., | 8 45 01.8 | I. C., | − | 1 45 | | | Dec., | 2° 42′ 36″ S. |
| R. A. ☾, | 11 38 39.3 | | − | 6 21 | | | p, | 92° 42′ 36″ |
| H. A. from Gr., | 2 53 37 E. | 1st corr., | + | 9′ 44″ | | | | |
| | | Approx. alt., | | 21° 27′ 54″ | | | | |
| | | p. & r. (Tab. 24), + | | 52 06 | Hor. par., | 58′ 35″ | | |
| | | h, | | 22 20 00 | | | | |

| | | | | |
|---|---|---|---|---|
| h | 22° 20′ 00″ | | | |
| L | 49 50 00 | | sec | .19043 |
| p | 92 42 36 | | cosec | .00049 |
| | 2)164 52 36 | | | |
| s | 82 26 18 | | cos | 9.11923 |
| s—h | 60 06 18 | | sin | 9.93799 |
| | | | | 2)19.24814 |

Gr. H. A.    2ʰ 53ᵐ 37ˢ E.
H. A.         3 19 04  E.            sin ½ t    9.62407

Long.    { 0ʰ 25ᵐ 27ˢ } W.
            { 6° 21′ 45″ }

**352.** EQUAL ALTITUDES.—The method of finding the longitude at sea by observation of *equal altitudes* of a heavenly body is one that may be conveniently employed when applicable, though the limits of applicability are narrow.

If, on board a vessel which is either stationary in position or moving at a uniform rate of speed in a true east or west direction, equal altitudes of the sun, a planet, or a star be observed before and after transit, and the times noted by chronometer or watch, the interval from meridian being not greater than ten minutes of time and the altitude not less than 75°, the mean of the times will be the time (by the chronometer or watch used) of the meridian passage of the body; from this may be found the Greenwich mean time of transit and thence the longitude.

If (the limits of time and altitude remaining as stated) observations be taken when the body bears not less than 80° from the meridian, the time of meridian passage may with accuracy be regarded as equal to the mean of the times of observation, no matter what course may have been steered by the vessel in the interval.

But if the azimuth of the body is less than 80° from the north or south point of the horizon the method is not available for vessels making a material amount of northing or southing; and if the hour angle is greater than 10ᵐ or the altitude less than 75°, it can not be accurately employed by any vessel, no matter what course is steered.   The navigator should not yield to the temptation offered by the simplicity of this method to follow it beyond the limits within which it may properly be considered to apply.

**353.** To deduce the longitude by this method take the mean of the watch times before and after transit, which will give the watch time of transit; correct this watch time in the usual manner for C—W and chronometer correction, from which is derived the Greenwich mean time of transit.

In the case of the sun, apply to the Greenwich mean time the equation of time, giving it its sign of application to mean time; the result is the Greenwich apparent time of transit, which is equal to the longitude if the latter is west, or to 24ʰ *minus* the longitude if east.

For other bodies, convert Greenwich mean time into Greenwich sidereal time by the usual method; the body being on the meridian, the local sidereal time is equal to the body's right ascension; the difference between Greenwich and local sidereal times is the longitude—east if the local time is greater, and west if it is less.

EXAMPLE: April 2, 1879, in Lat. 3° 30′ N., Long. 86° 00′ E., by D. R., observed equal altitudes of ☉ before and after noon, using same sextant and same height of eye.   Watch: a. m., 11ʰ 52ᵐ 37ˢ; p.m., 12ʰ 07ᵐ 22ˢ; C − W, 6ʰ 17ᵐ 48ˢ; C. C., + 2ᵐ 32ˢ.   Vessel steering west between sights.   Required the longitude at noon.

| | | |
|---|---|---|
| W. T., A. M., | 11ʰ 52ᵐ 37ˢ | Eq. t.,    3ᵐ 42ˢ.5 |
| W. T., P. M., | 12  07  22 | |
| | —————— | H. D.,    —    0ˢ.75 |
| | 2)23  59  59 | G. M. T.,   —    5ʰ.7 |
| W. T., L. A., noon, | 11  59  59.5 | Corr.,    +    4ˢ.3 |
| C − W, | + 6  17  48 | |
| | —————— | Eq. t.,    3ᵐ 46ˢ.8 |
| Chro. t., L. A., noon, | 6  17  47.5 | (*Subtract* from *mean* time.) |
| C. C., | +    2  32 | |
| G. M. T., L. A., noon, 1ᵈ, | 18  20  19.5 | |
| Eq. t., | —    3  46.8 | |
| G. A. T., L. A., noon, | - 18  16  33 | |
| Longitude, | { 5ʰ 43ᵐ 27ˢ } E. { 85° 51′ 45″ } | |

EXAMPLE: August 6, 1879, p. m., in Lat. 25° 55′ S., by obs., and Long. 36° 58′ W., by account, observed equal altitudes of the star Antares, the chronometer times before and after passage being 9ʰ 42ᵐ 38ˢ and 10ʰ 00ᵐ 26ˢ, and the true azimuths S. 81° E. and S. 81° W., respectively; chro. fast of G. M. T., 1ᵐ 27ˢ.   The ship was steaming on a course SSW.   What was the longitude?

| | |
|---|---|
| Chro. time before, | 9ʰ 42ᵐ 38ˢ |
| Chro. time after, | 10  00  26 |
| | 2)19  43  04 |
| Chro. time passage, | 9  51  32 |
| C. C., | —    1  27 |
| G. M. T. passage, | 9  50  05 |
| R. A. M. S., | + 8  58  36.3 |
| Red. (Tab. 9), | + 1  36.9 |
| G. S. T. passage, | 18  50  18.2 |
| L. S. T. passage (R. A. ✶), | 16  22  03.4 |
| Longitude, | { 2ʰ 28ᵐ 15ˢ } W. { 37° 03′ 45″ } |

# CHAPTER XIV.

## AZIMUTH.

**354.** The *azimuth* of a body has been defined (art. 223, Chap. VII) as the arc of the horizon intercepted between the meridian and the vertical circle passing through the body; and the *amplitude* (art. 224) as the arc measured between the position of the body when its true altitude is zero and the east or west point of the horizon. The amplitude is measured from the east point at rising and the west point at setting, and, if added to or subtracted from 90°, will agree with the azimuth of the body when in the true horizon. The azimuth is usually measured from the north point of the horizon in north latitude, and from the south point in south latitude, through 180° to the east or west; thus, if a body bore N. by E., its azimuth would be named N. 11¼° E. in north, or S. 168¾° E. in south latitude.

The determination of the azimuth of a celestial body is an operation of frequent necessity. At sea, the comparison of the true bearing with a bearing by compass affords the only means of ascertaining the error of the compass due to variation and deviation; on shore, the azimuth is required in order to furnish a knowledge of the variation, and is further essential in all surveying operations, the true direction of the base line being thus obtained.

**355.** There are various methods of obtaining the true azimuth of a celestial body, which will be described as follows: (*a*) *Amplitudes*, (*b*) *Time Azimuths*, (*c*) *Altitude Azimuths*, (*d*) *Time and Altitude Azimuths*. A further method, by means of the Sumner line, will be explained later (Chap. XV). Still another operation pertains to this subject, namely: (*e*) The determination of the *True Bearing of a Terrestrial Object*.

### AMPLITUDES.

**356.** The method of obtaining the compass error by amplitudes consists in observing the compass bearing of the sun or other celestial body when its center is in the true horizon, the true bearing, under such conditions, being obtained by a short calculation. Since the true horizon is not marked by any visible line (differing as it does from the visible horizon by reason of the effects of refraction, parallax, and dip), allowance may be made for the difference by an estimate of the eye, or else the observation may be made in the visible horizon and a correction applied.

**357.** When the center of the sun is at a distance above the horizon equal to its own diameter it is almost exactly in the true horizon; at such a time, note its bearing by compass, and also note (as in all observations for determining compass error) the ship's head by compass, and the angle and direction of the ship's heel.

Or, note the bearing at the instant at which the center of the body is in the visible horizon; in the case of the sun and moon, the correct bearing at that time may be most accurately ascertained by taking the mean of the bearings when the upper and the lower limbs of the disk are just appearing or disappearing.

**358.** *To find the true amplitude by computation* there are given the latitude, L, and declination, *d*. The quantities are connected by the formula,

$$\text{sin Amp.} = \text{sec L sin } d,$$

from a solution of which the amplitude is obtained.

*To find the true amplitude by inspection* enter Table 39 with the declination at the top and the latitude in the side column; under the former and opposite the latter will be given the true amplitude. To obtain accurate results, interpolate for minutes of latitude and declination.

*To reduce the observed amplitude* when taken in the visible horizon to what it would have been if taken in the true horizon, enter Table 40 with the latitude and declination to the nearest degree and apply the correction there found to the observed amplitude; the result will be the corrected amplitude by compass, which, by comparison with the true amplitude, gives the compass error. When the body observed is the sun, a star, or a planet, apply the correction, at rising in north latitude or at setting in south latitude, to the *right*, and at setting in north latitude or at rising in south latitude, to the *left*. For the moon, apply half the correction in a contrary direction.

EXAMPLE: At sea, in Lat. 11° 29′ N., the observed bearing of the sun, at the time of rising when its center was estimated to be one diameter above the visible horizon, was E. 31° N.; corrected declination 22° 32′ N. Required the compass error.

| | *By computation.* | | | *By inspection (Table 39).* | |
|---|---|---|---|---|---|
| L | 11° 29′ | sec | .00878 | L, 11°.5 N. | True amp. E. 23°. 0 N. |
| *d* | 22  32 | sin | 9.58345 | *d*, 22 .5 N. | |
| | | | | Obsd. amp. | E. 31 .0 N. |
| True amp. | E. 23° 01′ N. sin | | 9.59223 | | |
| Obsd. amp. | E. 31  00 N. | | | Error, | 8°. 0 E. |
| Error, | 7° 59′ E. | | | | |

EXAMPLE: At sea, in Lat. 25° 03′ S., the observed bearing of Venus when in the visible horizon at rising was E. 18° 30′ N., its declination being 21° 44′ N. Required the compass error.

| *By computation.* | | | *By inspection (Table 39).* | | |
|---|---|---|---|---|---|
| L 25° 03′ | sec | .04290 | L, | 25°.0 S.} | True amp. E. 24°.1 N. |
| d 21 44 | sin | 9.56854 | d, | 21 .7 N.} | |
| | | | Obsd. amp. | E. 18°.5 N. } | |
| True amp. E. 24° 08′ N. sin | | 9.61144 | Corr. (Tab. 40) | 0. 3 left.} | Comp. amp. E. 18 .8 N. |
| Comp. amp. E. 18 48 N. | | | | | |
| | | | Error, | | 5°. 3 W. |
| Error, | 5° 20′ W. | | | | |

EXAMPLE: At sea, in Lat. 40° 27′ N., the mean of the observed bearings of the upper and lower limbs of the moon when in contact with the visible horizon at setting was W. 17° S.; declination, 21° 12′ S. What was the error of the compass?

| *By computation.* | | | *By inspection (Table 39).* | | |
|---|---|---|---|---|---|
| L 40° 27′ | sec | .11863 | L, | 40°.5 N.} | True amp. W. 28°.4 S. |
| d 21 12 | sin | 9.55826 | d, | 21 .2 S.} | |
| | | | Obsd. amp. | W. 17°. 0 S. | |
| True amp. W. 28° 22′ S. sin | | 9.67689 | Corr. (Tab. 40) | 0. 3 right.} | Comp. amp. W. 16 .7 S. |
| Comp. amp. W. 16 42 S. | | | | | |
| | | | Error, | | 11°.7 W. |
| Error, | 11° 40′ W. | | | | |

## TIME AZIMUTHS.

**359.** In this method are given the hour angle at time of observation, $t$, the polar distance, $p$, and the latitude, L; to find the azimuth, Z.

Any celestial body bright enough to be observed with the azimuth circle may be employed for observation; the conditions are, however, most favorable for solution when the altitude is low.

**360.** Take a bearing of the object, bisecting it if it has an appreciable disk, and note the time with a watch of known error. Record, as usual, the ship's head by compass and the amount of heel. If preferred, a series of bearings may be taken with their corresponding times, and the means taken.

**361.** First prepare the data as follows:

(a) Find the Greenwich time corresponding to the local time of observation.

(b) Take out the declination of the body from the Nautical Almanac; if the method of computation is employed the polar distance and the co-latitude should be noted.

(c) Find the hour angle of the body by rules heretofore given.

This having been done, the true azimuth may be determined either by *Time Azimuth Tables*, by the graphic method of an *Azimuth Diagram*, or by *Solution of the Astronomical Triangle*. Owing to the possibility of more expeditious working, either of the first-named two is to be considered preferable to the last, and the navigator is recommended to supply himself with a copy of a book of Azimuth Tables, or with an Azimuth Diagram; an explanation of the method of use accompanies each of these.

**362.** To solve the triangle:

Let S = ½ sum of polar distance and co-Lat.
D = ½ difference of polar distance and co-Lat.
½t = ½ hour angle.
Z = true azimuth.

Then, tan X = sin D cosec S cot ½ t;
tan Y = cos D sec S cot ½ t;
Z = X + Y, or X ~ Y.

*First Case.*—If the half-sum of the polar distance and co-Lat. is *less* than 90°: take the sum of the angles X and Y if the polar distance is *greater* than the co-Lat.; take the difference if the polar distance is *less* than the co-Lat.

*Second Case.*—If the half-sum of the polar distance and co-Lat. is *greater* than 90°: always take the difference of X and Y, which subtract from 180°, and the result will be the true azimuth.

In either case, mark the true azimuth N. or S. according to the latitude, and E. or W. according to the hour angle. It may sometimes be convenient to use the supplement of the true azimuth, by subtracting it from 180° and reversing the prefix N. or S., in order to make it correspond to the compass azimuth when the latter is less than 90°.

The cotangent of half the hour angle may be found from Table 44 abreast the *whole* hour angle in the column headed "Hour P. M."

EXAMPLE: December 3, 1879, a. m., in Lat. 30° 25′ N., Long. 5h 25m 42s W., the observed bearing of sun's center was N. 135° 30′ E., and the Greenwich mean time, December 3, 2h 36m 11s. The corrected declination of the sun was 22° 07′ S.; the equation of time (additive to mean time), 10m 03s. Required the error of the compass.

| G. M. T. (Dec. 3), | 2h 36m 11s | co-Lat., | 59° 35′ | t | 2h 39m 28s | cot ½ t | .44051 | cot ½ t | .44051 |
| Long., | − 5 25 42 | p, | 112 07 | S | 85° 51′ | cosec | .00114 | sec | 1.14045 |
| | | | | D | 26 16 | sin | 9.64596 | cos | 9.95267 |
| L. M. T. (Dec. 2), | 21 10 29 | p+co-L, | 171 42 | | | | | | |
| Eq. t., | +  10 03 | | | X | 50 44 | tan | .08761 | | |
| | | S, | 85 51 | Y | 88 19 | | | tan | 1.53363 |
| L. A. T., | 21 20 32 | | | | | | | | |
| t, | 2h 39m 28s | p−co-L, | 52° 32′ | X+Y | 139 03 | | | | |
| | | D, | 26 16 | | | | | | |

True azimuth, N. 139° 03′ E.
Comp. azimuth, N. 135 30 E.

Compass error, 3 33 E.

EXAMPLE: April 9, 1879, in Lat. 2° 16′ N., the observed bearing of the sun's center was N. 85° 15′ E: sun's hour angle, 3h 44m 16s, and its declination, 7° 38′ N. Required the compass error.

| co-Lat., | 87° 44′ | t | 3h 44m 16s | cot ½ t | .27372 | cot ½ t | .27372 |
| p, | 82 22 | S | 85° 03′ | cosec | .00162 | sec | 1.06406 |
| | | D | 2 41 | sin | 8.67039 | cos | 9.99952 |
| p+co-L, | 170 06 | | | | | | |
| | | X | 5 03 | tan | 8.94573 | | |
| S, | 85 03 | Y | 87 22 | | | tan | 1.33730 |
| co-L−p, | 5° 22′ | Y−X | 82 19 | | | | |
| D, | 2 41 | | | | | | |

True azimuth, N. 82° 19′ E.
Comp. azimuth, N. 85 15 E.

Compass error, 2 56 W.

EXAMPLE: April 26, 1879, Lat. 16° 32′ S., observed bearing of Venus 56° 00′ W., its hour angle being 4h 27m 31s, and its declination 23° 12′ N. What was the error of the compass?

| co-Lat., | 73° 28′ | t | 4h 27m 31s | cot ½ t | .18022 | cot ½ t | .18022 |
| p, | 113 12 | S | 93° 20′ | cosec | .00074 | sec | 1.23549 |
| | | D | 19 52 | sin | 9.53126 | cos | 9.97335 |
| p+co-L, | 186 40 | | | | | | |
| | | X | 27 16 | tan | 9.71222 | | |
| S, | 93 20 | Y | 87 40 | | | tan | 1.38906 |
| p−co-L, | 39° 44′ | Y−X | 60 24 | | | | |
| D, | 19 52 | Z | 119° 36′ | | | | |

True azimuth, S. 119° 36′ W.
Comp. azimuth, S. 124 00 W.

Compass error, 4 24 W.

## ALTITUDE AZIMUTHS.

**363.** This method is employed when the altitude of the body is observed at the same time as the azimuth; in such a case the hour angle need not be known, though the time of observation should be recorded with sufficient accuracy for the correction of the declination of the sun, moon, or a planet.

There are given the altitude, h, the polar distance, p, and the latitude, L; to find the azimuth, Z.

**364.** Take a bearing of the body by compass, bisecting it if the disk is of appreciable diameter, and simultaneously measure the altitude; note the time approximately. Observe also the ship's heading (by compass) and the heel.

Or a series of azimuths, with corresponding altitudes, may be observed, and the mean employed.

**365.** Calculate the true altitude and declination from the observed altitude and the time. Then compute the true azimuth from the following formula:

$$\cos \tfrac{1}{2} Z = \sqrt{\cos s \cos (s-p) \sec L \sec h},$$

in which $s = \tfrac{1}{2} (h + L + p)$. The resulting azimuth is to be reckoned from the north in north latitude and from the south in south latitude.

It may occur that the term $(s-p)$ will have a negative value, but since the cosine of a negative angle less than 90° is positive, the result will not be affected thereby.

EXAMPLE: December 3, 1879, in Lat. 30° 25′ N., the observed bearing of the sun's center was N. 135° 30′ E., and its corrected altitude 24° 59′; the approximate G. M. T. was 2ʰ.6, the declination at that time being 22° 07′ S.   Required the compass error.

| | | | |
|---|---|---|---|
| $h$ | 24° 59′ | sec | .04267 |
| L | 30  25 | sec | .06431 |
| $p$ | 112  07 | | |

| | | | | |
|---|---|---|---|---|
| | 2 ) 167  31. | | | |
| $s$ | 83  45 | cos | 9.03690 | |
| $s-p$ | − 28  22 | cos | 9.94445 | |
| | | | 2 ) 19.08833 | |
| ½ Z | 69  30 | cos | 9.54416 | |
| Z | 139  00 | | | |

True azimuth,   N. 139° 00′ E.
Comp. azimuth, N. 135  30  E.
_____
Compass error,           3  30  E.

## TIME AND ALTITUDE AZIMUTHS.

**366.** When, at the time of observing the compass bearing of a celestial body, the altitude is measured and the exact time noted, the true azimuth may be very expeditiously determined, a knowledge of the latitude being unnecessary.

In view of the simplicity of the computation this method strongly commends itself to observers not provided with an azimuth table or diagram.

**367.** The observation is identical with that of the altitude azimuth (art. 364), with the exception that the times of observation must be *exactly* instead of *approximately* noted.

**368.** Ascertain the declination of the body at time of sight, and correct the observed altitude; compute the hour angle.   We then have:

$$\sin Z = \sin t \cos d \sec h,$$

from which the azimuth may be found.

This method has a defect in that there is nothing to indicate whether the resulting azimuth is measured from the north or the south point of the horizon; but as the approximate azimuth is always known, cases are rare when the solution will be in question.

EXAMPLE: December 3, 1879, in Lat. 30° 25′ N., Long. 5ʰ 25ᵐ 42ˢ W., the observed bearing of the sun's center was N. 135° 30′ E.; its altitude at the time was 24° 59′; hour angle, 2ʰ 39ᵐ 28ˢ (39° 52′), and declination 22° 07′ S.   Find the compass error.   (See example under Altitude Azimuths and first example under Time Azimuths.)

| | | |
|---|---|---|
| $t$ | 39° 52′ | sin 9.80686 |
| $d$ | 22  07 | cos 9.96681 |
| $h$ | 24  59 | sec  .04267 |
| Z S. 40° 56′ E. | | sin 9.81634 |

True azimuth,   N. 139° 04′ E.
Comp. azimuth, N. 135  30  E.
_____
                3  34  E.

## TRUE BEARING OF A TERRESTRIAL OBJECT.

**369.** Thus far, sea observations for combined variation and deviation have been discussed, but if it becomes necessary, as in surveying, to ascertain the *True Bearing of a Terrestrial Object*, or to find the variation at a shore station, more accurate methods than the foregoing must be resorted to.

The most reliable method is that by an *Astronomical Bearing*.   This consists in finding the true bearing of some well-defined object by taking the angle between it and the sun or other celestial body with a sextant or a theodolite, and simultaneously noting the time by chronometer, or measuring the altitude, or observing both time and altitude.   It should always be noted whether the object is right or left of the sun.

**370.** *By Sextant.*—Measure the angular distance between the object and the sun's limb; and if there is a second observer, measure the altitude of the sun at the same moment and note the time.   In the absence of an assistant, first measure the altitude of the sun; next, the angular distance between the sun and the object; then, a second altitude of the sun, noting the time of each observation.   Also measure the altitude of the defined point above the sea or shore horizon.

*By Theodolite.*—This instrument is far more convenient than the sextant, for, being leveled, the horizontal angle between the sun and the object is at once given, no matter what may be the altitudes of the objects.   In case the altitude of the sun is needed, it may be read accurately enough from the vertical circle, although not as finely graduated as the limb of the sextant.   The error in altitude must, however, be found by the level attached to the telescope, since it will usually be found to differ from the levels of the horizontal circle.   If, in directing the telescope to the sun, there is no colored eye-piece, an image of the sun may be cast on a piece of white paper held at a little distance from the eye-piece, and by adjusting the focus the shadow of the cross-wires will be seen.

It should be understood that any celestial body may be used as well as the sun, and there are, in fact, certain advantages in the use of the stars; the sun is chosen for illustration, because it will usually be found most convenient to employ that body.

**371.** Find the true azimuth of the celestial body by any one of the methods previously explained in this chapter and apply to it the azimuth difference, or horizontal angle between the celestial and the terrestrial body, having regard to the direction of one from the other.

To find the azimuth difference from sextant observations, change the observed altitudes of the bodies into *apparent* altitudes by correcting them for index error of the sextant, dip, and semidiameter; change the observed angular distance into *apparent* angular distance, by correcting for index error and semidiameter. Then if S = ½ (App. Dist. + App. Alt. ☉ + App. Alt. Object), we have:

$$\cos \tfrac{1}{2} \text{ Az. Diff.} = \sqrt{\overline{\sec \text{App. Alt.} \odot \sec \text{App. Alt. Object} \cos S \cos (S - \text{App. Dist.})},}$$

whence the azimuth difference is deduced.

When the theodolite is used, the horizontal angle is given directly. If only one limb of the sun is observed, it will be necessary to apply a correction for semidiameter (S. D. × sec h), but it is usual to eliminate this correction by taking the mean of observations of both limbs.

EXAMPLE: December 10, 1879, a. m., in Lat. 30° 25′ 24″ N., Long. 81° 25′ 24″ W., made observations with a sextant and obtained the following data for finding the true bearing of a station:

| | | | | | |
|---|---|---|---|---|---|
| Watch time, | 11ʰ 22ᵐ 36ˢ | Obs. Ang. Dist. ☉, | 117° 07′ Left. | Dec. S., | 22° 56′ 27″ |
| C − W, | 5 21 18 | Obs. 2 ☉, | 71° 37′ 20″ | Eq. t., + | 7ᵐ 00ˢ |
| Chro. corr., + | 2 16 | Obs. alt. Station, | 20′ | S. D., | 16′ 17″ |
| | | I. C., | zero. | | |

Required the true bearing of the object.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W. T., | 11ʰ 22ᵐ 36ˢ | 2 ☉, | 71° 37′ 20″ | *t* | 8° 08′ 00″ | sin 9.15069 |
| C − W, | 5 21 18 | | | *d* | 22 56 27 | cos 9.96422 |
| | | ☉, | 35 48 40 | *h* | 36 03 37 | sec .09239 |
| Chro. t., | 4 43 54 | S. D., + | 16 17 | | | |
| C. C., + | 2 16 | | | z { S. | 9° 17′ E. | sin 9.20730 |
| | | App. Alt., | 36 04 57 | { N. | 170 43 E. | |
| G. M. T., Dec. 10, | 4 46 10 | p. & r., − | 1 13 | | | |
| Eq. t., + | 7 00 | | | | | |
| | | *h*, | 36 03 44 | | | |
| G. A. T., | 4 53 10 | | | | | |
| Long., | − 5 25 42 | | | | | |
| | | | | | | |
| L. A. T., | 23 27 28 | | | | | |
| | | | | | | |
| *t*, | {0ʰ 32ᵐ 32ˢ | | | | | |
| | {8° 08′ 00″ | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Obs. Ang. Dist., | 117° 07′ 00″ | App. Dist. | 117° 23′ | | | True bearing ☉, | N. 170° 43′ E. |
| ☉'s S. D., + | 16 17 | App. Alt. ☉ | 36 05 | sec 0.09250 | Az. Diff., | 125 00 Left. |
| | | App. Alt. Object | 20 | sec 0.00001 | | |
| App. Ang. Dist., | 117 23 17 | | | | True bearing object, | N. 45° 43′ E. |
| | | 2)153 48 | | | | |
| | | | | | | |
| | | S | 76 54 | cos 9.35536 | | |
| | | S − App. Dist. | − 40 29 | cos 9.88115 | | |
| | | | | | | |
| | | | | 2)19.32902 | | |
| | | | | | | |
| | | ¼ Az. Diff. | 62° 30′ | cos 9.66451 | | |
| | | Az. Diff. | 125 00 | | | |

EXAMPLE: Same date and place and same objects as in the preceding example; measurement made with a theodolite, angular distance ⚲, 123° 17′; object left of sun. Watch time, 11ʰ 16ᵐ 34ˢ.5; watch slow of L. A. T., 4ᵐ 53ˢ.5. Dec. ☉, 22° 56′ S. Required the true bearing.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| W. T., | 11ʰ 16ᵐ 34ˢ.5 | co-Lat., | 59° 35′ | *t* | 0ʰ 38ᵐ 32ˢ | cot ½ *t* | 1.07435 | cot ½ *t* | 1.07435 |
| W. slow, + | 4 53.5 | *p*, | 112 56 | S | 86° 15′ | cosec | .00093 | sec | 1.18440 |
| | | | | D | 26 41 | sin | 9.65230 | cos | 9.95110 |
| L. A. T., | 23 21 28 .0 | *p* + co-L, | 172 31 | | | | | | |
| | | | | X | 79° 24′ | tan | .72758 | | |
| *t*, | 0 38 32 | S, | 86 15 | Y | 89 39 | | | tan | 2.20985 |
| | | | | | | | | | |
| | | *p* − co-L, | 53 21 | X + Y | 169 03 | | | | |
| | | | | | | | | | |
| | | D, | 26 41 | | | | | | |

True bearing ☉, N. 169° 03′ E.
Az. Diff., 123 17 Left.

True bearing object, N. 45 46 E.

# CHAPTER XV.

# THE SUMNER LINE.

### DESCRIPTION OF THE LINE.

**372.** The method of navigation involving the use of the Sumner line takes its name from Capt. Thomas H. Sumner, an American shipmaster, who discovered it and published it to the world. As a proof of its value, the incident which led to its discovery may be related:

"Having sailed from Charleston, S. C., 25th November, 1837, bound for Greenock, a series of heavy gales from the westward promised a quick passage; after passing the Azores the wind prevailed from the southward, with thick weather; after passing longitude 21° W. no observation was had until near the land, but soundings were had not far, as was supposed, from the bank. The weather was now more boisterous, and very thick, and the wind still southerly; arriving about midnight, 17th December, within 40 miles, by dead reckoning, of Tuskar light, the wind hauled SE. true, making the Irish coast a lee shore; the ship was then kept close to the wind and several tacks made to preserve her position as nearly as possible until daylight, when, nothing being in sight, she was kept on ENE. under short sail with heavy gales. At about 10 a. m. an altitude of the sun was observed, and the chronometer time noted; but, having run so far without observation, it was plain the latitude by dead reckoning was liable to error and could not be entirely relied upon."

The longitude by chronometer was determined, using this uncertain latitude, and it was found to be 15′ E. of the position by dead reckoning; a second latitude was then assumed 10′ north of that by dead reckoning, and toward the danger, giving a position 27 miles ENE. of the former position; a third latitude was assumed 10′ farther north, and still toward the danger, giving a third position ENE. of the second 27 miles. Upon plotting these three positions on the chart, they were seen to be in a straight line, and this line passed through Smalls light.

"It then at once appeared that the observed altitude must have happened at all the three points and at Smalls light and at the ship at the same instant."

Then followed the conclusion that, although the absolute position of the ship was uncertain, she must be somewhere on that line. The ship was kept on the course ENE., and in less than an hour Smalls light was made, bearing ENE. ½ E. and close aboard.

The latitude by dead reckoning was found to be 8′ in error, and if the position given by that latitude had been assumed correct the error would have been 8 miles too far S. and 31′ 30″ of longitude too far W., and the result to the ship might have been disastrous had this wrong position been adopted. This represents one of the practical applications of the Sumner line.

The properties of the line thus found will now be explained.

**373.** Circles of Equal Altitude.—In figure 43, if EE′E″ represent the earth projected upon the horizon of a point A, and if it be assumed that, at some particular instant of time, a celestial body is in



FIG. 43.

the zenith of that point, then the true altitude of the body as observed at A will be 90°. In such a case the great circle EE′E″, which forms the horizon of A, will divide the earth into two hemispheres, and from any point on the surface of one of those hemispheres the body will be visible, while over the whole of the other hemisphere it will be invisible. The great circle EE′E″, from the fact of its marking the limit of illumination of the body, is termed the *circle of illumination*, and from any point on its circumference the true altitude of the center of the body will be zero. If, now, we consider any small circle of the sphere, BB′B″, CC′C″, DD′D″, whose plane is parallel to the plane of the circle of illumination and which lies within the hemisphere throughout which the body is visible, it will be apparent that the true altitude of the body at any point of one of these circles is equal to its true altitude at any other point of the same circle; thus, the altitude of the body at B is equal to its altitude at B′ or B″, and its altitude at D is the same as at D′ or D″.

It therefore follows that at any instant of time there is a series of positions on the earth at which a celestial body appears at the same given altitude, and these positions lie in the circumference of a circle described upon the earth's surface whose center is at that position which has the body in the zenith, and whose radius depends upon the zenith distance, or—what is the same thing—upon the altitude. Such circles are termed *circles of equal altitude.*

**374.** The data for an astronomical sight comprise merely the time, declination, and altitude. The first two fix the position of the body and may be regarded as giving the latitude and longitude of that point on the earth in whose zenith the body is found; the zenith distance (the complement of the altitude) indicates the distance of the observer's zenith from that point; but there is nothing to show at which of the numerous positions fulfilling the required conditions the observation may have been taken. A number of navigators may measure the same altitude of a body at the same instant of time, at places thousands of miles apart; and each proceeds to work out his position with identical data, so far as this sight is concerned. It is therefore clear that a single observation is not enough, in itself, to locate the point occupied by the observer, and it becomes necessary, in order to fix the position, to employ a second circle, which may be either that of another celestial body or that of the same body given by an observation when it is in the zenith of some other point than when first taken; knowing that the point of observation lies upon each of two circles, it is only possible that it can be at one of their two points of intersection; and since the position of the ship is always known within fairly close limits, it is easy to choose the proper one of the two. Figure 44 shows the plotting of observations of two bodies vertically over the points A and A′ upon the earth, the zenith distances corresponding respectively to the radii AO and A′O.

**375.** THE SUMNER LINE.—In practice, under the conditions existing at sea, it is never necessary to determine the whole of a circle of equal altitude, as a very small portion of it will suffice for the purposes of navigation; the position is always known within a distance which will seldom exceed thirty miles under the most unfavorable conditions, and which is usually very much less; in the narrow limits thus required, the arc of the circle will practically coincide with the tangent at its middle point, and may be regarded as a straight line. Such a line, comprising so much of the circle of equal altitude as



FIG. 44.

covers the probable limits of position of the observer, is called a *Sumner line* or *Line of position*.

**376.** Since the direction of a circle at any point—that is, the direction of the tangent—must be perpendicular to the radius at that point, it follows that the Sumner line always lies in a direction at right angles to that in which the body bears from the observer. Thus, in figure 44, it may be seen that *m m′* and *n n′*, the extended Sumner lines corresponding to the bodies at A and A′, are respectively perpendicular to the bearings of the bodies OA and OA′. This fact has a most important application in the employment of the Sumner line.

**377.** USES OF THE SUMNER LINE.—The Sumner line is valuable because it gives to the navigator a knowledge of all of the probable positions of his vessel, while a sight worked with a single assumed latitude or longitude gives but one of the probable positions; it must be recognized that, in the nature of things, an error in the assumed coordinate will almost invariably exist, and its possible effect should be taken into consideration; the line of position reveals the difference of longitude due to an error in the latitude, or the reverse.

Since the Sumner line is at right angles to the bearing, it may be seen that when the body bears east or west—that is, when it is on the prime vertical—the resulting line runs north and south, coinciding with a meridian; if, in this case, two latitudes are assumed, the deduced longitudes will be the same. When the body bears north or south, or is on the meridian, the line runs east and west and becomes identical with a parallel of latitude; in such a case, two assumed longitudes will give the same latitude. Any intermediate bearing gives a Sumner line inclined to both meridians and parallels; if the line agrees in direction more nearly with the meridian, latitude should generally be assumed and the longitude worked; if it is nearer a parallel, the reverse course is usually preferable. The values of the assumed coordinates may vary from 10′ to 1°, according to circumstances.

**378.** The greatest benefit to be derived from the Sumner method is when two lines are worked and their intersections found. The two lines may be given by different bodies, which is generally preferable, or two different lines may be obtained from the same body from observations taken at different times. The position given by the intersection of two lines is more accurate the more nearly the lines are at right angles to each other, as an error in one line thus produces less effect upon the result. When two observations of the same body are taken, the position of the ship at the time of first sight must be brought forward to that at the second in considering the intersection; if, for example, a certain line is determined, and the ship then runs NW. 27 miles, it is evident that her new position is on a line parallel with the first and 27 miles to the NW. of it; a second line being obtained, the intersection of this with the first line, as corrected for the run, gives the ship's position.

Besides the employment of two lines for intersections with each other, a single line may be made to serve various useful purposes for the navigator. These are described in article 400, Chapter XVI.

## METHODS OF DETERMINATION.

**379.** Any line may be defined in either of two ways—by two of its points, or by one point and the direction. There are thus two methods by which a Sumner line may be determined:

(*a*) Assume two values of one coordinate and find the corresponding values of the other. Two values of the latitude may be assumed and the longitudes determined, as was done by Captain Sumner on the occasion that led to the discovery of the method; or else two values of the longitude may be assumed and the latitudes determined. Two points are fixed in this way, and the line joining them is the line of position.

(*b*) Assume either one latitude or one longitude and determine the corresponding coordinate. This gives one point of the line. The azimuth of the body is then ascertained, and a line is drawn through
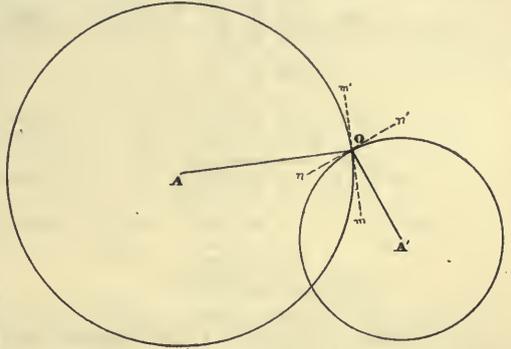
the determined point at right angles to the direction in which the body bore at the time of sight. This will be the line of position.

**380.** It follows that if the Sumner line be located by the first method and its direction thus defined, the azimuth of the observed body may be determined by finding the angle made by the line with the meridian and adding or substracting 90°.

EXAMPLE: At sea April 17, 1879, A. M., in Lat. 25° 12′ S., Long. 31° 32′ W., by D. R., observed an altitude of the planet Jupiter, east of the meridian, 45° 40′; watch time, $5^h$ $48^m$ $02^s$; C — W, $2^h$ $05^m$ $42^s$; C. C., $+2^m$ $18^s$; I. C., $+1′$ 30″; height of eye, 18 feet. Required the Sumner line.

From a solution of this same problem for a single longitude (art. 351, Chap. XIII), the following were found: H. A. from Gr., $0^h$ $50^m$ $51^s$ E.; $h$, 45° 36′ 24″; $p$, 79° 22′ 51″. Assume values of Lat. 25° 02′ and 25° 22′ S.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $h$ | 45° 36′ 24″ | | | | | | | | |
| $L_1$ | 25 02 00 | | sec | .04284 | | $L_2$ | 25° 22′ 00″ | sec | .04403 |
| $p$ | 79 22 51 | | cosec | .00750 | | | | cosec | .00750 |
| | 2)150 01 15 | | | | | | | | |
| $s_1$ | 75 00 38 | | cos | 9.41270 | | $s_2$ | 75 10 38 | cos | 9.40794 |
| $s_1 - h$ | 29 24 14 | | sin | 9.69105 | | $s_2 - h$ | 29 34 14 | sin | 9.69328 |
| Gr. H. A. | $0^h$ $50^m$ $51^s$ E. | | 2)19.15409 | | | Gr. H. A. | $0^h$ $50^m$ $51^s$ | 2)19.15275 | |
| H. A.$_1$ | 2 57 29 E. | | sin $\frac{1}{2} t_1$ | 9.57704 | | H. A.$_2$ | 2 57 12 | sin $\frac{1}{2} t_2$ | 9.57638 |

$$\text{Long.}_1 \begin{cases} 2^h\ 06^m\ 38^s \\ 31°\ 39′\ 30″ \end{cases} \text{W.} \qquad \text{Long.}_2 \begin{cases} 2^h\ 06^m\ 21^s \\ 31°\ 35′\ 15″ \end{cases} \text{W.}$$

It should be observed that $s_2$ and $s_2 - h$ can be obtained, respectively, from $s_1$ and $s_1 - h$ by adding half the difference between $L_1$ and $L_2$; also that log cosec $p$ is the same for both hour angles. The determination of the second hour angle is thus considerably simplified.

A comparison of these results with those obtained by the solution with a single latitude shows that the hour angle, and consequently the longitude, corresponding to the latitude 25° 12′ S. are the means of those corresponding to the latitudes here used; and therefore that the assumption that the Sumner line is a straight line is accurate.

The line of the same sight might also have been found as follows:

Working with the single latitude 25° 12′ S., it was found that the corresponding longitude was 31° 37′ 30″ W. Now by referring to an azimuth table or azimuth diagram, the azimuth corresponding to Lat., 25°.2 S., Dec., 10°.6 S., H. A., $2^h$ $57^m$. 3 E. is S. 100° 58′ E.; therefore the Sumner line extends S. 10° 58′ E.

The line may therefore be defined in either of two ways, thus:

$$A_1 \begin{cases} 25°\ 02′\ 00″\ \text{S.} \\ 31\ 39\ 30\ \text{W.} \end{cases} \qquad A_2 \begin{cases} 25°\ 22′\ 00″\ \text{S.} \\ 31\ 35\ 15\ \text{W.} \end{cases}$$

Or,  $$A \begin{cases} 25°\ 12′\ 00″\ \text{S.} \\ 31\ 37\ 30\ \text{W.} \end{cases} \qquad \text{Line runs S. 10° 58′ E.}$$

By inspection of the coordinates of $A_1$ and $A_2$ it may be seen that—

+ 20′ diff. lat. makes — 4′.25 diff. long.; or,
+ 20 miles diff. lat. makes — 3.8 miles departure.

Therefore by reference to Table 2 it appears that the line runs about S. 11° E., and the azimuth of the body is S. 101° E.; thus the results obtained by the two methods agree.

EXAMPLE: At sea, May 18, 1879, A. M., Lat. 41° 33′ N., Long. 33° 30′ W., by D. R., the mean of a series of observed altitudes of the sun's lower limb was 29° 35′ 30″; the mean watch time, $7^h$ $20^m$ $45^s$.3; C. C., $+4^m$ $59^s$.2; I. C., $-30″$; height of the eye, 23 feet; C—W, $2^h$ $17^m$ $06^s$. Required the Sumner line.

From a solution of this same problem for a single longitude (art. 351, Chap. XIII) the following were found: G. A. T., $21^h$ $46^m$ $38^s$; $h$, 29° 50′ 05″; $p$, 70° 29′ 14″. Assume values of the latitude 41° 03′ and 42° 03′ N.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $h$ | 29° 50′ 05″ | | | | | | | | |
| $L_1$ | 41 03 00 | | sec | .12255 | | $L_2$ | 42° 03′ 00″ | sec | .12927 |
| $p$ | 70 29 14 | | cosec | .02569 | | | | cosec | .02569 |
| | 2)141 22 19 | | | | | | | | |
| $s_1$ | 70 41 09 | | cos | 9.51950 | | $s_2$ | 71 11 09 | cos | 9.50852 |
| $s_1 - h$ | 40 51 04 | | sin | 9.81564 | | $s_2 - h$ | 41 21 04 | sin | 9.81999 |
| G. A. T. | $21^h$ $46^m$ $38^s$ | | 2)19.48338 | | | G. A. T. | $21^h$ $46^m$ $38^s$ | 2)19.48347 | |
| L. A. T.$_1$ | 19 32 08 | | sin $\frac{1}{2} t_1$ | 9.74169 | | L. A. T.$_2$ | 19 32 06 | sin $\frac{1}{2} t_2$ | 9.74174 |

$$\text{Long.}_1 \begin{cases} 2^h\ 14^m\ 30^s \\ 33°\ 37′\ 30″ \end{cases} \text{W.} \qquad \text{Long.}_2 \begin{cases} 2^h\ 14^m\ 32^s \\ 33°\ 38′\ 00″ \end{cases} \text{W.}$$

$$A_1 \begin{cases} 41°\ 03′\ 00″\ \text{N.} \\ 33\ 37\ 30\ \text{W.} \end{cases} \qquad A_2 \begin{cases} 42°\ 03′\ 00″\ \text{N.} \\ 33\ 38\ 00\ \text{W.} \end{cases} \qquad \begin{array}{l} + 60′ \text{ diff. lat. makes} + 0′.5 \text{ long.} \\ + 60 \text{ miles diff. lat. makes} + 0.4 \text{ mile departure.} \end{array}$$

Line runs, N. $\frac{1}{2}$° W.  Azimuth, N. $89\frac{1}{2}$° E.

The same sight worked with a single latitude, 41° 33′ N., as was done in the original example, with azimuth taken from tables or diagram, gives:

$$A \begin{cases} 41° 33′ 00″ \text{ N.} \\ 33 \;\; 37 \;\; 45 \text{ W.} \end{cases} \qquad \begin{array}{l} \text{Azimuth, N. 89° 38′ E.} \\ \text{Line runs, N. 0° 22′ W.} \end{array}$$

This example illustrates the case in which an observation is taken practically on the prime vertical; the azimuth shows the bearing to be within 0° 22′ of true East, and the Sumner line is therefore within 0° 22′ of the meridian; a variation of 30′ in either direction from the dead reckoning latitude makes a difference of only 15″ in the longitude.

EXAMPLE: May 28, 1879, in Lat. 6° 20′ S. by account, Long. 30° 21′ 30″ W.; chro. time, 7$^h$ 35$^m$ 10$^s$; observed altitude of moon's upper limb, 75° 33′ 00″, bearing north and east; I. C., — 3′ 00″; height of eye, 26 feet; chro. fast of G. M. T., 1$^m$ 37$^s$.5.   Required the Sumner line.

From a solution of the same problem with a single longitude (art. 339, Chap. XII), the following values were obtained: H. A. from Greenwich, 1$^h$ 35$^m$ 07$^s$ W.; $h$, 75° 23′ 30″; $d$, 6° 41′ 47″ N.   Assume the longitudes 30° 10′ and 30° 30′ W.

| | | | | | |
|---|---|---|---|---|---|
| | Gr. H. A. 1$^h$ 35$^m$ 07$^s$ W. | | | Gr. H. A. 1$^h$ 35$^m$ 07$^s$ | |
| | Long.₁   2  00  40  W. | | | Long.₂   2  02  00 | |
| | $t_1 \begin{cases} 0^h 25^m 33^s \\ 6° 23′ 15″ \end{cases}$ | | | $t_2 \begin{cases} 0^h 26^m 53^s \\ 6° 43′ 15″ \end{cases}$ | |
| $t_1$   6° 23′ 15″ | sec   :00270 | | | | |
| $d$   6  41  47 | tan 9.06973 | cosec .93324 | | | |
| $h$   75  23  30 | | sin 9.98573 | $A_1 \begin{cases} 6° 27′ 03″ \text{ S.} \\ 30 \;\; 10 \;\; 00 \text{ W.} \end{cases}$ | | |
| $\varphi''_1$   6  44  17  N. | tan 9.07243 | sin 9.06942 | | | |
| $\varphi'_1$   13  11  20  S. | | cos 9.98839 | | | |
| Lat.₁   6  27  03  S. | | | | | |
| $t_2$   6° 43′ 15″ | sec .00299 | | | | |
| $d$   6  41  47 | tan 9.06973 | cosec .93324 | | | |
| $h$   75  23  30 | | sin 9.98573 | $A_2 \begin{cases} 6° 16′ 27″ \text{ S.} \\ 30 \;\; 30 \;\; 00 \text{ W.} \end{cases}$ | | |
| $\varphi''_2$   6  44  33 | tan 9.07272 | sin 9.06972 | | | |
| $\varphi'_2$   13  01  00 | | cos 9.98869 | | | |
| Lat.₂  6  16  27 S. | | | | | |

Working by the other method, and finding the azimuth, we have:

$$A \begin{cases} 6° 21′ 14″ \text{ S.} \\ 30 \;\; 21 \;\; 30 \text{ W.} \end{cases} \qquad \text{Line runs N. 62° W.}$$

It might be shown that the results check with each other, as in previous cases.

EXAMPLE: At sea, July 12, 1879, in Lat. 50° N., Long. 40° W., observed circum-meridian altitude of the sun's lower limb, the time by a chronometer regulated to Greenwich mean time being 2$^h$ 41$^m$ 39$^s$; chro. corr., — 2$^m$ 30$^s$; I. C., —3′ 0″; height of the eye, 15 feet.   Find the Sumner line.

From the solution of the same problem for a single latitude (art. 338, Chap. XII) the following values were obtained: G. A. T., 2$^h$ 33$^m$ 50$^s$; $h$, 61° 57′ 01″; $d$, 21° 59′ 27″ N.; $a$ (Tab. 26), 2″ .5. Assume longitudes 39° 45′ and 40° 15′ W.

| | | | | | |
|---|---|---|---|---|---|
| | Gr. H. A.   2$^h$ 33$^m$ 50$^s$ | | | Gr. H. A.   2$^h$ 33$^m$ 50$^s$ | |
| | Long.₁   —2  39  00 | | | Long.₂   —2  41  00 | |
| $t_1$ | 5  10 | | $t_2$ | 7  10 | |
| $h$ | 61° 57′ 01″ | | $h$ | 61° 57′ 01″ | |
| $at_1{}^2$ | +   1  06 | | $at_2{}^2$ | +   2  08 | |
| H₁ | 61  58  07 | | H₂ | 61  59  09 | |
| $z_1$ | 28  01  53  N. | | $z_2$ | 28  00  51 | |
| $d$ | 21  59  27  N. | | $d$ | 21  59  27 | |
| L₁ | 50  01  20  N. | | L₂ | 50  00  18  N. | |

The line given by these coordinates is then:

$$A_1 \begin{cases} 50° 01′ 20″ \text{ N.} \\ 39 \;\; 45 \;\; 00 \text{ W.} \end{cases} \qquad A_2 \begin{cases} 50° 00′ 18″ \text{ N.} \\ 40 \;\; 15 \;\; 00 \text{ W.} \end{cases}$$

This shows that the Sumner line lies so nearly in a due east-and-west direction that a difference of longitude of 30′ makes a difference of latitude of only 1′.

From an azimuth table or diagram, it is found that the azimuth of the sun corresponding to Lat. 50° N. Dec. 22° N. and H. A. 6ᵐ 10ˢ E., is N. 177° E. Therefore, using the values given by the earlier solution, the line is defined as follows:

$$A \begin{cases} 50° \ 00′ \ 51″ \ \text{N.} \\ 40 \ \ 00 \ \ 00 \ \ \text{N.} \end{cases} \quad \text{Line runs N. 87° E.}$$

The direction of the line thus given and the one found from the double coordinates may be shown to agree as in examples before given.

## FINDING THE INTERSECTION OF SUMNER LINES.

**381.** The intersection of Sumner lines may be found either graphically or by computation.

**382.** Graphic Methods.—Each line may be plotted upon the chart of the locality in which the ship is being navigated and the intersection thus found. The details of the plotting will be obvious, whether the line is defined by two of its points, or by one point and its direction. This plan will commend itself especially when the vessel is near shore, as the chart in use will then probably be one of conveniently large scale, and it will be an advantage to see where the position falls with reference to soundings and landmarks.

**383.** When clear of the land it is often inconvenient to follow this plan; a large scale chart may not be at hand, it may not be desired to deface the chart with numerous lines, or the necessary space for chart work may not be available. In such a case, the following method[a] is recommended, as it obviates the disadvantages of the other.

To understand the principle of this method, suppose that the lines are defined by the latitude and longitude of two points of each, and consider that they are plotted on a chart which is constructed upon a sheet of elastic rubber. It is evident that if, while holding it fast in the direction of the meridians, we stretch this rubber along the lines of the parallels in a uniform manner until the length of each minute of longitude is made to equal a minute of latitude, the chart, while losing its accuracy as portraying actual conditions on the earth's surface, still correctly represents the positions of the various points in terms of the new coordinates which have been created, namely, those in which a minute of latitude is equal to a minute of longitude. Thus, if on the true chart a point is $m$ minutes north and $n$ minutes east of another, on the stretched one it will still be $m$ minutes north and $n$ minutes east, the only difference being that the minutes of longitude will now be of a different length; and if on the original chart the two Sumner lines intersect at a point $m$ minutes north and $n$ minutes east (on the original scale) of some definite point of one of the lines, the intersection on the stretched chart will lie $m$ minutes north and $n$ minutes (of the new scale) to the east of the same point.

A stricter mathematical conception of the stretched chart and its properties may perhaps be obtained by considering the chart of the locality to be projected (with the eye at the zenith) upon a plane which passes through one of the meridians and makes an angle with the plane of the horizon which is equal to the latitude; each minute of longitude will then be increased by multiplying it by the secant of the latitude, and thus becomes equal to a minute of latitude.

From a consideration of the properties of this hypothetical chart it may be seen that the following rule may be laid down: If two or more Sumner lines be plotted by their latitude and longitude upon any sheet of paper, using a scale whereon latitude and longitude are equal regardless of the latitude of the locality, the intersection of those lines, measured by coordinates on the scale employed, correctly represents the intersection of the lines as it would be measured upon a true chart.

It follows from this that we may plot Sumner lines upon any piece of paper, measuring the coordinates with an ordinary scale ruler, and assigning any convenient length for the mile; the larger the scale the more accurate will be the determination. Or, what is even more convenient, we may employ "profile paper," whereon lines are ruled at right angles to each other and at equal distances apart, in which case no scale ruler is needed.

One caution must be observed in using this method; all longitudes employed on the paper for any purpose must be those of the scale, namely, one minute of longitude equals one minute of latitude. For instance, if the two Sumner lines be taken at different times, in bringing the first up to the position of the second by the intermediate run, that run must be laid down to scale; that is, the easting or westing must appear as so many minutes of longitude, not so many miles. To do this enter the traverse table with course and distance run, and pick out latitude and departure; then, by means of the middle latitude, convert departure into minutes of longitude and bring the first line to the second by laying off so many minutes of latitude north or south, and so many of longitude east or west.

In the case where the Sumner is defined by one position and its line of direction, it is not correct to lay down the angle to the meridian on the hypothetical chart, for all angles are distorted thereon. The best way is to find another position on the line by assuming a second latitude ten or twenty miles removed from that of the point given, entering the traverse table with the angle that the line makes with the meridian as a course, and abreast the latitude taking out the departure; convert departure into difference of longitude, and plot the second point by its coordinates from the first.

Example: Let it be required to find the intersection, by each of the methods, of the following lines:

$$A_1 \begin{cases} 40° \ 00′ \ \text{N.} \\ 63 \ \ 15 \ \ \text{W.} \end{cases} \qquad A_2 \begin{cases} 40° \ 20′ \ \text{N.} \\ 63 \ \ 07 \ \ \text{W.} \end{cases}$$

$$B_1 \begin{cases} 40 \ \ 05 \ \ \text{N.} \\ 63 \ \ 03 \ \ \text{W.} \end{cases} \qquad B_2 \begin{cases} 40 \ \ 15 \ \ \text{N.} \\ 63 \ \ 12 \ \ \text{W.} \end{cases}$$

---

[a] Suggested by Lieut. G. W. Logan, U. S. Navy.

Figure 45 shows the intersection, (1) by Mercator chart, (2) by scale, and (3) on profile paper, as follows:



1 mile = .06 inch.
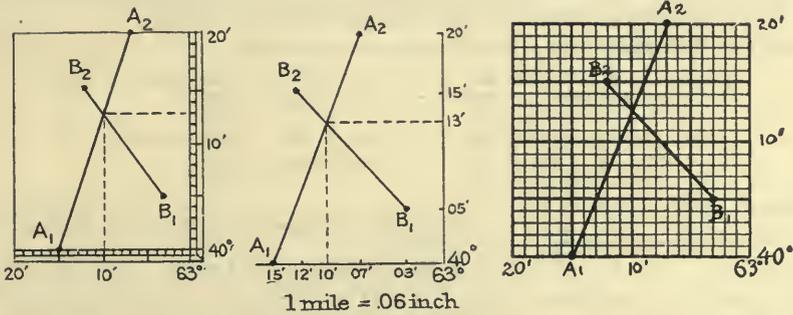
FIG. 45.

Intersection: $\begin{cases} 40° \ 12'.8 \ \text{N.} \\ 63 \ \ 09 \ .9 \ \text{W.} \end{cases}$

Suppose, in the example just given, the first line had been defined as follows:

$A \begin{cases} 40° \ 00' \ \text{N.} \\ 63 \ \ 15 \ \ \text{W.} \end{cases}$   Line runs N. 17° E.

To find a second coordinate by which to plot it, proceed as follows:
In Table 2, for 17°: Lat. 20′ N., Dep. 6.1 m. E.   For Mid. Lat.: 40°, Dep. 6.1 m., diff. long. 8′.0 E.
Hence, as previously given:

$A_1 \begin{cases} 40° \ 00' \ \text{N.} \\ 63 \ \ 15 \ \ \text{W.} \end{cases}$        $A_2 \begin{cases} 40° \ 20' \ \text{N.} \\ 63 \ \ 07 \ \ \text{W.} \end{cases}$

**384.** METHODS BY COMPUTATION.[a]—The finding of the intersection of two Sumner lines by computation may be divided into two cases:
*Case I.* When one line lies in a NE.–SW. direction, and the other in a NW.–SE. direction.
*Case II.* When both lie in a NE.–SW., or both in a NW.–SE. direction.
Suppose, first, that the lines are defined by the latitude and longitude of two points of each, and for the simplification of the problem consider the lines projected on a plane passing through one of the meridians and making an angle with the plane of the horizon equal to the latitude, the properties of which were explained under the graphic method, (art. 383); this saves the necessity of converting minutes of longitude into miles of departure before the solution and converting them back again afterwards; as all points are thus projected in corresponding relative positions, the results are as exact as if the longer method be followed of dealing with minutes of latitude and longitude of unequal length.

**385.** *Case I. One line NE.–SW., and the other NW.–SE.*— Suppose the two lines, projected as described, are as shown in figure 46, $A_1 A_2$ and $B_1 B_2$; for the present assume that the two points, $A_1$ and $B_1$, have a common latitude. Drop the perpendicular PO from the intersection; then the latitude of the intersection will be a distance OP above the common latitude of $A_1$ and $B_1$, and its longitude will be a distance $A_1O$ to the right of $A_1$ and $B_1O$ to the left of $B_1$.
Find the angles $\alpha$ and $\beta$ from the traverse table (Table 2), they being taken out with the difference of latitude between the two points of the same line in the column Lat. and the difference of longitude in the column Dep. (Do not overlook the fact that we are dealing now with the plane of projection and that $\alpha$ and $\beta$ are not the angles made by the Sumner line with



FIG. 46.

meridians on the earth's surface.) The solution may now be accomplished by either of two methods:
(a) Observe that the case is the same as if a ship were steaming along the line $A_1 B_1$ and took the first bearing of the point P when at $A_1$, at an angle from the course equal to 90°−$\alpha$, and the second bearing when at $B_1$, at an angle from the course equal to 90°+$\beta$, with an intervening run equal to the difference of longitude $A_1 B_1$; or, she may be considered as steaming from $B_1$ to $A_1$, in which case the first angle is 90°−$\beta$ and the second 90°+$\alpha$. Picking out of Table 5 B, corresponding to the angles given, the quantity in the *second* column, we shall have the ratio of the distance of *passing abeam*, OP, to the distance $A_1 B_1$; multiply the difference of longitude by this ratio, and we shall have the actual length of OP. Then entering the traverse table with this as a latitude and $\alpha$ as a course, we find in the departure column the distance $A_1O$ by which the longitude of OP is defined; it is recommended also to pick out $B_1O$, using the angle $\beta$, which affords a proof of the correctness of all work done after the finding of $\alpha$ and $\beta$.
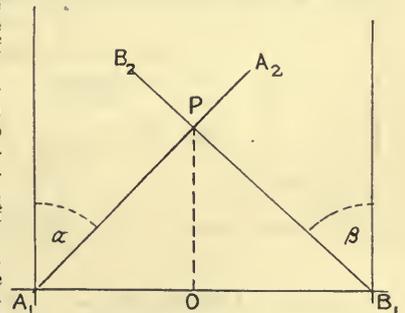
[a] Suggested by Lieut. G. W. Logan, U. S. Navy.

(b) The second method is to find by trial and error some latitude such that its departure corresponding to $\alpha$, *plus* its departure corresponding to $\beta$, equals the difference of longitude $A_1 B_1$; then the point will be defined by the latitude, and by its longitude from $A_1$ and $B_1$, the agreement of the longitude as established from the different points furnishing a check upon the operation.

EXAMPLE: Find the intersection of the following Sumner lines:

$$A_1 \begin{cases} 49°\ 40'\ \text{N}. \\ 6\ \ 55.3\ \text{W}. \end{cases} A_2 \begin{cases} 50°\ 00'\ \text{N}. \\ 7\ \ 20.0\ \text{W}. \end{cases} \begin{array}{l} +20'\ \text{lat}. \\ +24.7\ \text{long}. \end{array} \begin{array}{l} \text{Line runs NW.-SE.} \\ \alpha = 51°. \end{array}$$

$$B_1 \begin{cases} 49\ \ 40\ \ \text{N}. \\ 6\ \ 32.5\ \text{W}. \end{cases} B_2 \begin{cases} 50\ \ 00\ \ \text{N}. \\ 6\ \ 11.3\ \text{W}. \end{cases} \begin{array}{l} +20\ \ \text{lat}. \\ -21.2\ \text{long}. \end{array} \begin{array}{l} \text{Line runs NE.-SW.} \\ \beta = 47°. \end{array}$$

Longitude $A_1 B_1 = 22'.8$.



FIG. 47.

First draw a rough sketch (fig. 47) to illustrate the direction of coordinates.

Notice that $A_1$ is west of $B_1$. The line through $A_1$ runs NW.–SE. That through $B_1$, NE.–SW. The intersection is therefore south of both, east of $A_1$, and west of $B_1$.

(a) To solve by Table 5 B: First bearing $(90° - \alpha) = 39°$; second bearing $(90° + \beta) = 137°$. Corresponding ratio, 0.43, multiplied by $22'.8 = 9'.8$ lat. (The angles $90° - \beta$ and $90° + \alpha$ would have given the same ratio, 0.43.) Then (Table 2) with $\alpha = 51°$, lat. $= 9'.8$, dep. $= 12'.1$; and with $\beta = 47°$, lat. $= 9'.8$, dep. $= 10'.5$.

Hence, intersection:

$$\begin{array}{lll} 9'.8\ \text{S. of lat.} & 49°\ 40'\ \text{N.} & = 49°\ 30'.2\ \text{N.} \\ 12\ .1\ \text{E. of long.} & 6\ \ 55.3\ \text{W.} & = \ 6°\ 43\ .2\ \text{W.} \\ 10\ .5\ \text{W. of long.} & 6\ \ 32.5\ \text{W.} & = \ 6°\ 43\ .0\ \text{W.} \end{array} \Big\} \text{check}.$$

(b) To solve by Table 2:

| Assuming lat | 5′ | 8′ | 10′ | 9′.9 |
|---|---|---|---|---|
| Dep. for 51° | 6.2 | 9.7 | 12.3 | 12.2 |
| Dep. for 47° | 5.3 | 8.5 | 10.7 | 10.6 |
| Sum | 11.5 | 18.2 | 23.0 | 22.8 |

Hence, intersection:

$$\begin{array}{lll} 9'.9\ \text{S.} & \text{of}\ 49°\ 40' & = 49°\ 30'.1. \\ 12\ .2\ \text{E.} & \text{of}\ \ 6\ \ 55.3 = & 6\ \ 43\ .1 \\ 10\ .6\ \text{W.} & \text{of}\ \ 6\ \ 32.5 = & 6\ \ 43\ .1 \end{array} \Big\} \text{check}.$$

It may be seen that the results by the two methods substantially agree.

**386.** *Case II. Both lines NE.-SW., or both NW.-SE.*—Consider the lines as drawn in figure 48, and continue the assumption that $A_1$ and $B_1$ have a common latitude. The differences from the first case by both methods simply involve a change of signs.



FIG. 48.

(a) If the ship is steaming from $A_1$ toward $B_1$, the first angle from the keel line is $90° - \alpha$, and the second, $90° - \beta$; if steaming from $B_1$ toward $A_1$, the first angle is $90° + \beta$, and the second $90° + \alpha$; in other words, either add both angles to $90°$ or subtract both from $90°$ and enter with the smaller angle as the first bearing.

(b) It may be seen that $OA_1 - OB_1 = A_1 B_1$; in other words, to solve by the second method, the values must be so found that the *difference* of the corresponding departures equals the difference of longitude, instead of their sums, as before.

EXAMPLE: Find the intersection of the Sumner lines defined below:

$$A_1 \begin{cases} 49°\ 30'\ \text{N}. \\ 5\ \ 24.8\ \text{W}. \end{cases} A_2 \begin{cases} 49°\ 50' \\ 5\ \ 21.5 \end{cases} \begin{array}{l} +20'\ \text{lat}. \\ -3.3\ \text{long}. \end{array} \begin{array}{l} \text{Line runs NE.-SW.} \\ \alpha = 9°. \end{array}$$

$$B_1 \begin{cases} 49\ \ 30\ \ \text{N}. \\ 5\ \ 25.8\ \text{W}. \end{cases} B_2 \begin{cases} 49\ \ 50 \\ 4\ \ 52.1 \end{cases} \begin{array}{l} +20\ \ \text{lat}. \\ -33.7\ \text{long}. \end{array} \begin{array}{l} \text{Line runs NE.-SW.} \\ \beta = 59°. \end{array}$$

$$A_1 B_1 = 1'.0.$$



FIG. 49.

In this case (fig. 49) $B_1$ is west of $A_1$, the lines both run NE.–SW., and $\beta$ is the greater angle; therefore intersection lies to the north and east of both points.

(a) By Table 5 B: First course $(90° + \alpha) = 99°$; second course $(90° + \beta) = 149°$; ratio $0.67 \times 1'.0 = 0'.7$; or, first course $(90° - \beta) = 31°$; second course $(90° - \alpha) = 81°$; ratio $= 0.67$, as before.

$\alpha = 9°$, lat. $= 0'.7$, dep. $= 0'.1$; and $\beta = 59°$, lat. $= 0'.7$, dep. $= 1'.2$.

Hence, intersection:

$$0'.7 \text{ N. of } 49° 30' \quad \text{N.} = 49° 30'.7 \text{ N.}$$
$$0.1 \text{ E. of } 5 \quad 24.8 \text{ W.} = 5 \quad 24.7 \text{ W.} \left.\right\} \text{ check.}$$
$$1.2 \text{ E. of } 5 \quad 25.8 \text{ W.} = 5 \quad 24.6 \text{ W.} \left.\right\}$$

(b) By Table 2:

| Assuming lat | 2'.0 | 0'.5 | 0'.6 |
|---|---|---|---|
| Dep. for 9° | 0.3 | 0.1 | 0.1 |
| Dep. for 59° | 3.3 | 0.9 | 1.1 |
| Difference | 3.0 | 0.8 | 1.0 |

Hence, intersection:

$$0'.6 \text{ N. of } 49° 30' \quad = 49° 30'.6$$
$$0.1 \text{ E. of } 5 \quad 24.8 = 5 \quad 24.7 \left.\right\} \text{ check.}$$
$$1.1 \text{ E. of } 5 \quad 25.8 = 5 \quad 24.7 \left.\right\}$$

**387.** In discussing these cases, we have assumed that there was a point of one line which had a common latitude with a point of the other line; this would be the case if two lines were worked from time sights taken at the same time. It may occur, however, either that they have not a common lati-tude, but do have a common longitude, as in the case of two lines worked from $\varphi'$ $\varphi''$ (latitude) sights taken at the same time; or that they have neither a common latitude nor a common longitude, as with one time sight and one latitude sight, or with two sights taken at different times.
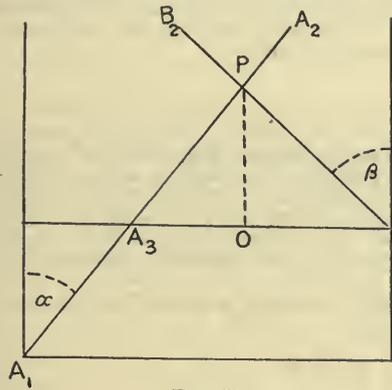
In case there is a common longitude (fig. 50), which will be rather a rare one, the problem is worked with OP as a *longitude* co-ordinate; the modification of the other method will suggest itself, the principal change rendered necessary being due to the fact that the angles from the course in Table 5 B will be complementary to what they were before, as we are now dealing with angles to the meridian instead of angles to the parallel.
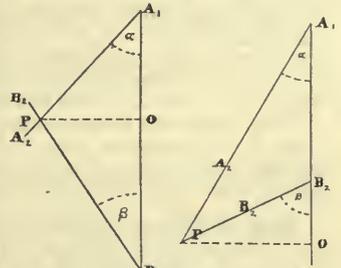
When there is no common coordinate of either latitude or longitude, the simplest way of solving is first to find some point on one line which corresponds in latitude with one of the points on the other line, then solve as before.

Thus, in figure 51, given $A_1 A_2$ and $B_1 B_2$, find $\alpha$ and $\beta$, and thence the longitude of a point $A_3$ corresponding to the difference of latitude between $A_1$ and $B_1$ on the course $\alpha$; then find intersection of $A_3 A_2$ and $B_1 B_2$ in the usual way.



FIG. 50.



FIG. 51.

EXAMPLE: Let it be required to find the intersection of. Sumner lines as follows:

$$A_1 \left\{ \begin{array}{l} 25° 30' \text{ S.} \\ 115 \quad 22 \text{ E.} \end{array} \right. \quad A_2 \left\{ \begin{array}{l} 25° 50' \text{ S.} \\ 115 \quad 40 \text{ E.} \end{array} \right. \quad \begin{array}{l} +20' \text{ lat.} \\ +18 \text{ long.} \end{array} \quad \begin{array}{l} \text{Line runs SE.–NW.} \\ \alpha = 42°. \end{array}$$

$$B_1 \left\{ \begin{array}{l} 25 \quad 15 \text{ S.} \\ 115 \quad 37 \text{ E.} \end{array} \right. \quad B_2 \left\{ \begin{array}{l} 25 \quad 35 \text{ S.} \\ 115 \quad 30 \text{ E.} \end{array} \right. \quad \begin{array}{l} +20 \text{ lat.} \\ -7 \text{ long.} \end{array} \quad \begin{array}{l} \text{Line runs NE.–SW.} \\ \beta = 19° \end{array}$$

Find where $B_1 B_2$ crosses parallel 25° 30′ S.
$\beta = 19°$, lat. $= +15'$, dep. $= -5'.1$. Hence, the line $B_3 B_2$ becomes:

$$B_3 \left\{ \begin{array}{l} 25° 30' \text{ S.} \\ 115 \quad 31.9 \text{ E.} \end{array} \right. \quad A_1 B_3 = 9'.9 \quad \begin{array}{l} \text{Line runs NE.–SW.} \\ \beta = 19°. \end{array}$$

The directions of the lines (fig. 52) require us to follow Case I. $A_1$ is west of $B_3$. The line through $A_1$ runs SE.–NW., and that through $B_3$, SW.–NE. Therefore, the intersection is south of $A_1$ and $B_3$, east of $A_4$, and west of $B_3$.

(a) By Table 5 B. $(90° - \alpha) = 48°$, $(90° + \beta) = 109°$. Ratio $0.81 \times 9'.9 = 8'.0$ lat.; $\alpha = 42°$, lat. $= 8'.0$, dep. $= 7'.2$. $\beta = 19°$; lat. $= 8'.0$, dep. $= 2'.7$.
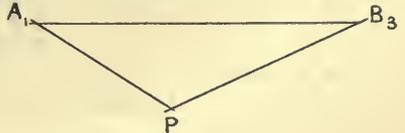


FIG. 52.

Hence, intersection:

$$8' \text{ S. of } 25° 30' \quad \text{S.} = 25° 38' \text{ S.}$$
$$7.2 \text{ E. of } 115 \quad 22 \quad \text{E.} = 115 \quad 29.2 \text{ E.} \left.\right\} \text{ check.}$$
$$2.7 \text{ W. of } 115 \quad 31.9 \text{ E.} = 115 \quad 29.2 \text{ E.} \left.\right\}$$

(b) By Table 2:

| Assuming lat | 6' | 8' |
|---|---|---|
| Dep. for 42° | 5.5 | 7.2 |
| Dep. for 19° | 2.1 | 2.7 |
| Sum | 7.6 | 9.9 |

Intersection:

$$8'\ \text{S.}\ \text{ of }\ 25°\ 30'\ =\ 25°\ 38'$$
$$7.2\ \text{E.}\ \text{of } 115\ \ 22\ \ =115\ \ 29.2$$
$$2.7\ \text{W. of } 115\ \ 31.9\ =115\ \ 29.2$$
\}check.

**388.** The following is a summary of the method when lines are given by coordinates of two points of each:

(a) *By Table 5 B.*

1. Write down lines; find $\alpha$ and $\beta$.
2. If there are no points which have a common latitude, reduce one point of one line to latitude of some given point of the other.
3. Write down difference of longitude.
4. Draw rough sketch to illustrate direction of point of intersection.
5. Enter Table 5 B:
*Case I*, angles $(90° - \alpha)$ and $(90° + \beta)$ *or* $(90° - \beta)$ and $(90° + \alpha)$.
*Case II*, angles $(90° + \alpha)$ and $(90° + \beta)$ *or* $(90° - \beta)$ and $(90° - \alpha)$.
Take out ratio from *second* column, and multiply by difference of longitude; this gives difference of latitude of intersection from the common latitude.
6. Find departure corresponding respectively to $\alpha$ and $\beta$ with latitude; this gives differences of longitude to the point of intersection from the respective points of common latitude.

(b) *By Table 2.*

1. Write down lines; find $\alpha$ and $\beta$.
2. If there are no points which have a common latitude, reduce one point of one line to latitude of some given point of the other.
3. Write down difference of longitude.
4. Draw rough sketch to illustrate direction of point of intersection.
5. Enter Table 2, at pages $\alpha$ and $\beta$; find by trial some latitude at which—
*Case I*, the sum of the corresponding departures equals the total difference of longitude;
*Case II*, the difference of the corresponding departures equals the total difference of longitude.
These give differences of latitude and longitude to the point of intersection from the respective points of common latitude.

**389.** If the lines, instead of being defined by coordinates of two points, are defined by the coordinates of one point of each with its direction as deduced from the azimuth of the body, it will be better not to consider the projection on the fictitious plane through the meridian, as there will then be no advantage in so doing. In this case, consider the angles of the lines with the meridian, as given, $\alpha$ and $\beta$; reduce the difference of longitude of $A_1 B_1$ to departure, and use this in miles instead of the $A_1 B_1$ in minutes; and when $A_1O$ and $B_1O$ are found, being in miles of departure, they must be reduced to minutes of longitude before being applied to the longitude of $A_1$ and $B_1$.

EXAMPLE: The Sumner lines of the last example being expressed by a single point and the direction, as given below, find the intersection.

$$A\begin{cases} 25°\ 40'\ \ \text{S.} \\ 115\ \ 31\ \ \ \ \text{E.} \end{cases}\qquad \text{Line runs } (\alpha =)\ \text{N. } 39°\ \text{W.}$$

$$B\begin{cases} 25\ \ 25\ \ \ \ \text{S.} \\ 115\ \ 33.5\ \ \text{E.} \end{cases}\qquad \text{Line runs } (\beta =)\ \text{N. } 18°\ \text{E.}$$

First bring second line up to Lat. 25° 40′ S. $\beta = 18°$; lat. $= +15'$; dep. $= -4.9$ m.; diff. long. $= -5'.4$; hence we have:

$$B'\begin{cases} 25°\ 40'\ \ \text{S.} \\ 115\ \ 28.1\ \text{E.} \end{cases}\qquad \text{Line runs } (\beta =)\ \text{N. } 18°\ \text{E.}$$

FIG. 53.

$AB' = 2'.9 = 2.6$ miles.

$B'$ being west of A (fig. 53), and the lines through the two points running respectively NE. and NW., the intersection is north of both, east of $B'$, and west of A.

(a) By Table 5 B. $(90° - \alpha) = 51°$; $(90° + \beta) = 108°$. Ratio 2.0. $0.88 \times 2.6 = 2'.3$ lat. $\alpha = 39°$, lat. $= 2'.3$, dep. $= 1.8$ m., diff. long. $= 2.0$. $\beta = 18°$, lat. $= 2'.3$, dep. $= 0.7$ m., diff. long. $= 0.8$.
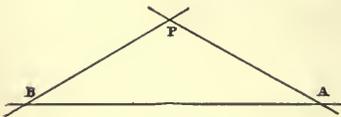
Intersection:

$$2'.3\ \text{N. of }\ \ 25°\ 40'\ \ \text{S.}\ =\ \ 25°\ 37'.7\ \text{S.}$$
$$2\ .0\ \text{W. of } 115\ \ 31\ \ \ \ \text{E.}\ = 115\ \ 29\ \ \ \ \text{E.}$$
$$0\ .8\ \text{E. of } 115\ \ 28.1\ \text{E.}\ = 115\ \ 28\ .9\ \text{E.}$$
\}check.

(b) By Table 2:

| | | | |
|---|---|---|---|
| Assuming lat | 4′ | 2′ | 2′.3 |
| Dep. for 39° | 3.2 | 1.6 | 1 .9 = 2′.1 |
| Dep. for 18° | 1.3 | 0.7 | 0 .7 = 0 .8 |
| Sum | 4.5 | 2.3 | 2 .6 = 2 .9 |

Intersection:

$$2'.3\ \text{N. of }\ \ 25°\ 40'\ =\ \ 25°\ 37'.7$$
$$2\ .1\ \text{W. of } 115\ \ 31\ \ \ = 115\ \ 28\ .9$$
$$0\ .8\ \text{E. of } 115\ \ 28.1\ = 115\ \ 28\ .9$$
\}check.

The following summary gives the various steps when the lines are each given by the coordinates of one point with the direction:

### (a) By Table 5 B.

1. Write down lines as given.
2. If the points have not a common latitude, reduce one point to latitude of the other.
3. Write down difference of longitude and convert it to departure.
4. Draw rough sketch to illustrate direction of point of intersection.
5. Enter Table 5 B:

*Case I*, angles $(90°-\alpha)$ and $(90°+\beta)$ *or* $(90°-\beta)$ and $(90°+\alpha)$.

*Case II*, angles $(90°+\alpha)$ and $(90°+\beta)$ *or* $(90°-\beta)$ and $(90°-\alpha)$.

Take out ratio from second column, and multiply by departure between the two points; this gives difference of latitude of intersection from common latitude.

6. Find departure corresponding respectively to $\alpha$ and $\beta$ with this difference of latitude, and convert to difference of longitude; this gives differences of longitude to the point of intersection from the respective points of common latitude.

### (b) By Table 2.

1. Write down lines as given.
2. If the points have not a common latitude, reduce one point to latitude of the other.
3. Write down difference of longitude and convert it to departure.
4. Draw rough sketch to illustrate direction of point of intersection.
5. Enter Table 2 at pages $\alpha$ and $\beta$; find by trial some latitude at which—

*Case I*, the sum of the corresponding departures equals the departure between the two points;

*Case II*, the difference of the corresponding departures equals the departure between the two points.

This difference of latitude, and these departures (converted into difference of longitude) give distance of point of intersection in latitude and longitude from the respective points of common latitude.

**390.** The modification of the methods for finding the intersection of two Sumner lines, where there is a run between the observations from which they are deduced, will be readily apparent. It is known that at the time of taking a sight the vessel is at one of the points of the Sumner line, but which of the various points represents her precise position must remain in doubt until further data are acquired. Suppose, now, that after an observation the vessel sails a given distance in a given direction; it is clear that while her exact position is still undetermined it must be at one of the series of points comprised in a line parallel to the Sumner line and at a distance and direction therefrom corresponding to the course and distance made good; hence, if a second sight is then taken, the position of the vessel may be found from the intersection of two lines—one, the Sumner line given by the second observation, and the other a line parallel to the first Sumner but removed from it by the amount of the intervening run.

Positions may be brought forward graphically on a chart by taking the course from the compass rose with parallel rulers, and the distance by scale with dividers. If the method given in article 383 be employed, runs in latitude and longitude must each be applied on their own scales, as explained in the description of the method. If one of the methods by computation be adopted, the point or points of the first line are brought forward by the traverse tables, using middle latitude sailing. The direction of a Sumner line as determined from the azimuth of the body always remains the same, whatever shift may be made in the position of the point by which the line is further defined.

# CHAPTER XVI.

## THE PRACTICE OF NAVIGATION AT SEA.

**391.** Having set forth in previous chapters the methods of working dead reckoning and of solving problems to find the latitude, longitude, chronometer correction, and azimuth from astronomical observations, it will be the aim of the present chapter to describe the conditions which govern the choice and employment of the various problems, together with certain considerations by which the navigator may be guided in his practical work at sea.

**392. Departure and Dead Reckoning.**—On beginning a voyage, a good departure must be taken while landmarks are still in view and favorably located for the purpose; this becomes the origin of the dead reckoning, which, with frequent new departures from positions by observation, is kept up to the completion of the voyage, thus enabling the mariner to know, with a fair degree of accuracy, the position of his vessel at any instant.

At the moment of taking the departure, the reading of the patent log (which should have been put over at least long enough previously to be regularly running) must be recorded, and thereafter at the time of taking each sight and at every other time when a position is required for any purpose, the log reading must also be noted. It is likewise well to read the log each hour, for general information as to the speed of the vessel as well as to observe that it is in proper running order and that the rotator has not been fouled by seaweed or by refuse thrown overboard from the ship. It is a good plan to record the time by ship's clock on each occasion that the log is read, as a supplementary means of arriving at the distance will thus be available in case of doubt. If a vessel does not use the patent log but estimates her speed by the number of revolutions of the engines or the indications of the chip log, the noting of the time becomes essential. A good sight is of no value unless one knows the point in the ship's run at which it was taken, so that the position it gave may be brought forward with accuracy to any later time.

**393. Routine Day's Work.**—The routine of a day's work at sea, no part of which should ever be neglected unless cloudy weather renders it impossible to follow, consists in working the dead reckoning, an a. m. time sight and azimuth taken when the sun is in its most favorable position for the purpose, a meridian altitude of the sun (or, when clouds interfere at noon, a sight for latitude as near the meridian as possible), and a p. m. time sight and azimuth. This represents the minimum of work, and it may be amplified as circumstances render expedient.

**394. Morning Sights.**—The morning time sight and azimuth should be observed, if possible, when the sun is on the prime vertical. As the body bears east at that time, the resulting Sumner line is due north and south, and the longitude will thus be obtained without an accurate knowledge of the latitude. Another reason for so choosing the time is that near this point of the sun's apparent path the body is changing most slowly in azimuth, and an error in noting the time will have the minimum effect in its computed bearing. The time when the sun will be on the prime vertical—that is, when its azimuth is 90°—may be found from the azimuth tables or the azimuth diagram. Speaking generally, during half the year the sun does not rise until after having crossed the prime vertical, and is therefore never visible on a bearing of east. In this case it is best to take the observation as soon as it has risen above the altitude of uncertain atmospheric effects—between 10° and 15°.

A series of several altitudes should be taken, partly because the mean is more accurate than a single sight, and partly because an error in the reading of the watch or sextant may easily occur when there is no repetition. If the sextant is set in advance of the altitude on even five or ten minute divisions of the arc, and the time marked at contacts, the method will be found to possess various advantages. As the sight is being taken the patent log should be read and ship's time recorded. It is well, too, to make a practice of noting the index correction of the sextant each time that the sextant is used. The bearing of the sun by compass should immediately afterward be observed, and the heading by compass noted, as also the time (by the same watch as was used for the sight).

Before working out the sight, the dead reckoning is brought up to the time of observation, and the latitude thus found used as the approximate latitude at sight. It is strongly recommended that *every sight be worked for a Sumner line,* either by assuming two latitudes, or by using one latitude and the azimuth, the advantages derived therefrom being always well worth the small additional labor expended.

The compass error is next obtained. From the time sight the navigator learns that his watch is a certain amount fast or slow of L. A. T., and he need only apply this correction to the watch time of azimuth to obtain the L. A. T. at which it was observed; thence he ascertains the sun's true bearing from the azimuth tables or azimuth diagram, compares it with the compass bearing, and obtains the compass error; he should subtract the variation by chart and note if the remainder, the deviation, agrees with that given in his deviation table; but in working the next dead reckoning, if the ship's course does not change, the total compass error thus found may be used without separating it into its component parts. It should be increased or decreased, however, as the ship proceeds, by the amount of any *change* of the variation that the chart may show.

**395.** If there is any fear of the weather being cloudy at noon, the navigator should take the precaution, when the sun has changed about 30° in azimuth, to observe a second altitude and to record the appropriate data for another sight, though this need not actually be worked unless the meridian

observation is lost. If it is required, it may be worked for either a time sight or $\varphi'$ $\varphi''$ sight, according to circumstances, a second Sumner line obtained, and the intersection of the earlier Sumner with it will give the ship's position.

**396.** Noon Sights.—Between 11 and 11.30 o'clock (allowing for gain or loss of time due to the day's run)·the ship's clocks should be set for the L. A. T. of the prospective noon position. The noon longitude may be closely estimated from the morning sight, and the probable run. The navigator should also set his own watch for that time, to the nearest minute, and note exactly the number of seconds that it is in error. He may now compute the constant (art. 333, Chap. XII) for the meridian altitude. The daily winding of the chronometer is a most important feature of the day's routine, and may well be performed at this hour. At a convenient time before noon, the observations for meridian altitude are commenced and continued until the watch shows L. A. noon, at which time the meridian altitude is measured and the latitude deduced.

If the weather is cloudy and there is doubt of the sun being visible on the meridian, an altitude may be taken at any time within a few minutes of noon, the time noted, and the interval from L. A. noon found from the known error of the watch. It is then the work of less than a minute to take out the $a$ from Table 26, the $at^2$ from Table 27, and apply the reduction to the observed altitude to obtain the meridian altitude. Indeed, the method is so simple that it may be practiced every day and several values of the meridian altitude thus obtained, instead of only one.

**397.** It now becomes necessary to find the longitude at noon. This may be done graphically by a chart, or by computation. The former plan needs no explanation. There are a number of variations in the methods of computation, one of which will be given as a type.

By the ship's run, work back the noon latitude to the latitude at a. m. time sight. If the Sumner line was found from two assumed latitudes which differed $+ m$ minutes, while the corresponding longitudes differed $\pm n$ minutes, then $1'$ difference of latitude causes $\pm \frac{n}{m}$ minutes difference of longitude. If the true latitude at sight is $\pm x$ minutes from one of the assumed latitudes, then $\pm x \times \frac{n}{m}$ is the corresponding difference of longitude. If the Sumner line was found from one assumed latitude and an azimuth, Z, it makes an angle with the meridian equal to $90° - Z$. Enter the traverse table with this as a course and with the difference between the true and assumed latitudes as a latitude, and the departure will be found; convert this into difference of longitude at the latitude of observation, and apply the result with its proper sign to the longitude corresponding to the assumed latitude. Having thus the longitude at sight, the longitude at noon is worked forward for the run. If the sights show a considerable current it should be allowed for, both in working back the latitude and in bringing up the longitude for the run between the sight and noon.

**398.** Current and Run.—The current may be found by comparing the noon positions as obtained by observation and by dead reckoning; and the day's run is calculated from the difference between the day's noon position by observation and that of the preceding day. To "current" is usually attributed all discrepancies between the dead reckoning and observations; but it is evident that this is not entirely due to motion of the waters, as it includes errors due to faulty steering, improper allowance for the compass error, and inaccurate estimate of the vessel's speed through the water.

The noon position by observation becomes the departure for the dead reckoning that follows.

**399.** Afternoon Sights.—The p. m. time sight and azimuth is similar to the morning observation.

**400.** Sumner Lines.—By performing the work that has just been described a good position is obtained at noon each day, which, in a slow-moving vessel with plenty of sea room, may be considered sufficient; but conditions are such at times as to render it almost imperatively necessary that a more frequent determination of the latitude and longitude be made. If the vessel is near the land or in the vicinity of off-lying dangers, if she is running a great circle course requiring frequent changes, if she is making deep-sea soundings, if she has just come through a period of foggy or cloudy weather, or if the indications are that she is about to enter upon such a period, it is obviously inexpedient to await the coming of the next noon for a fix. The responsibilities resting upon the navigator require that he shall earlier find his ship's position; and, generally speaking, the greater the speed made by the vessel the more absolute is this requirement.

The key to all such determinations will lie in the Sumner line, and a clear understanding of the properties of such a line will greatly facilitate the solutions. The mariner must keep in mind two facts: First, that a single observation of a heavenly body can never, by itself, give the *point* occupied by an observer on the earth's surface; and second, that whenever any celestial body is visible, together with enough of the horizon to permit the measuring of its altitude, an observer may thereby determine a *line* which passes through his own position on the earth's surface in a direction at right angles to the bearing of the body.

It may readily be seen that if two Sumner lines are determined the observer's position must be at their intersection, and that that intersection will be most clearly marked when the angle between the lines equals 90°; hence, if two heavenly bodies are in sight at the same time the position may be found from the intersection of their Sumner lines, the angle of intersection being equal to the horizontal angle between the bodies. If only one body is in sight, as is generally the case when the sun is shining, one line of position may be gotten from an altitude taken at one time, and a second line from another altitude taken when it has changed some 30° in azimuth—usually, a couple of hours later. Bringing forward the first line for the intervening run, the intersection may be found.

With the general principles of the Sumner line clearly before him, the navigator will find no difficulty in making the choice of available bodies. If about to take a star sight, and sky and horizon are equally good in all quarters, two bodies should be taken whose azimuths differ as nearly as possible by 90°. If one body can be taken on or near the meridian, its bearing being practically north or south, the resulting Sumner line will be east and west—that is, it may be said that whatever the longitude (within its known limits) the latitude will be the same; the other sight may then be worked as a time sight with this single latitude and time will thus be saved. The same is true if Polaris is observed, and it is a very convenient practice to take an altitude of that star at dawn and obtain a latitude for working

the a. m. time sight of the sun. A similar case arises when a body is observed on the prime vertical; its Sumner line then runs north and south and coincides with a meridian; if the other body is favorably located for a $\varphi'$ $\varphi''$ sight, it may be worked with a single longitude and the latitude thus found directly.

If it is not possible to obtain two lines and thus exactly locate the ship, the indications of a single line may be of great value to the navigator. A Sumner line and a terrestrial bearing will give the ship's position by their intersection in the same manner as two lines of position or two bearings; or the position of the ship on a line may be shown with more or less accuracy by a sounding or a series of soundings. If the body be observed when it bears in a direction at right angles to the trend of a neighboring shore line, the resulting line will be parallel with the coast and thus show the mariner his distance from the land, which may be of great importance even if his exact position on the line remains in doubt. If the bearing be parallel to the coast line, then the Sumner line will point toward shore; the value of a line that leads to the point that the vessel is trying to pick up is amply demonstrated by the experience of Captain Sumner that led to the discovery of the method (art. 372, Chap. XV).

For especially accurate work three Sumner lines may be taken, varying in azimuth about 120°; if they do not intersect in a point, the most probable position of the ship is at the center of the triangle that they form.

If two pairs of lines be determined, each pair based upon observation of two bodies bearing in nearly opposite directions and at about the same altitude, the mean position that results from the intersection of the four lines will be as nearly as possible free from those errors of the instrument, of refraction, and of the observer, which can not otherwise be eliminated. This is fully explained in article 451, Chapter XVII.

**401.** USE OF STARS, PLANETS, AND MOON.—It may be judged that the employment in navigation of other heavenly bodies than the sun is considered of the utmost importance, and mariners are urged to familiarize themselves with the methods by which observations of stars, planets, and the moon may be utilized to reveal to them the position of their vessels at frequent intervals throughout the twenty-four hours.

It should be remembered, however, that in order to be of value these observations must be accurate; and to measure an accurate altitude of the body above the horizon it is required not only that the body be visible but also that the horizon be distinctly in view. Care should therefore be taken to make the observations, if possible, at the time when the horizon is plainest—that is, during morning and evening twilight. It may be urgently required to get a position during hours of darkness, and a dim horizon line may sometimes be seen and an observation taken, using the star telescope of the sextant; if the moon is shining, its light will be a material aid; but results obtained from such sights should be regarded as questionable and used with caution. Altitudes measured, however, just before sunrise and just after sunset are open to no such criticism; a fairly well-practiced observer who takes a series of sights at such a time, setting the sextant for equal intervals of altitude, will find the regularity of the corresponding time intervals such as to assure him of accuracy.

**402.** IDENTIFICATION OF UNKNOWN BODIES.—On account of the very great value to be derived from the use of stars and planets in navigation, it is strongly recommended that all navigators familiarize themselves with the names and positions of those fixed stars whose magnitude renders possible their employment for observations, and also with the general characteristics—magnitude and color—of the three planets (Venus, Jupiter, and Mars) which are most frequently used. A study of the different portions of the heavens, with the aid of any of the numerous charts and books which bear upon the subject, will enable the navigator to recognize the more important constellations and single stars by their situation with relation to each other, and to the pole and the equator.

It may occur, however, that occasion will arise for observing a body whose name is not known, either because it has not been learned, or because the surrounding stars by which it is usually identified are obscured by clouds or rendered invisible by moonlight or daylight. In such a case the observer may estimate the hour angle and declination (the hour angle applied to local sidereal time giving the right ascension), and the star or planet may thus be recognized from a chart or from an inspection of the Nautical Almanac. This rough method will generally suffice when the body is the only one of its magnitude within an extensive region of the heavens; but cases often arise where a much closer approximation is necessary, and more exact data is required for identification.

**403.** If in doubt as to the name of the body at the time of taking the sight, it should be made an invariable rule to observe its bearing by compass, whence the true azimuth may be approximately deduced by applying the compass error. The method [a] to be described then affords a convenient means of identification. The quantities given are the corrected altitude of observation, $h$, the (approximate) true azimuth of the body, Z, and the latitude by dead reckoning, L; those to be determined are the declination, $d$, and the hour angle, $t$. From the astronomical triangle we have:

$$\frac{\sin Z}{\sin p} = \frac{\sin t}{\cos h}; \text{ or, } \sin Z \cos h = \sin t \cos d.$$

The value of $\sin Z \cos h$ (calculated from the given azimuth and altitude) must therefore equal $\sin t \cos d$, whatever the values of $t$ and $d$ may prove to be.

From a given latitude, azimuth and declination, the hour angle may be found either by azimuth tables or an azimuth diagram; or from a given latitude, azimuth and hour angle, the declination may be found by the same means. If, therefore, some probable value of the declination be assumed, using the known latitude and azimuth, we may ascertain the corresponding hour angle; or, if the hour angle be assumed, the corresponding declination is obtained; then the product of $\sin t \cos d$ may be calculated, and if it agrees substantially with $\sin Z \cos h$, the trial values of the hour angle and declination are the correct ones; if not, other trials may be made until the correct ones are found. It may be remembered that absolutely exact results are not sought, and in practice the operation may be made very short; the

---

a Suggested by Lieut. G. W. Logan, U. S. Navy.

values of the quantities may be taken in even degrees and the logarithms need not be carried beyond the third place; the sum of the logarithms will suffice and the corresponding numbers do not have to be taken out. The possibility that the observed body may have been a planet must always be kept in mind in looking it up in the star table or chart.

EXAMPLE: May 16, 1879, in Lat. 5° N., Long. $2^h 53^m$ W. by D. R., a star is observed whose corrected altitude is 38°, and true azimuth N. 107° E. The Greenwich sidereal time (as computed for use in the regular working of the sight) is $12^h 53^m$. Let it be required to identify the body.

First find the logarithm of sin Z cos h.

$$\begin{array}{lll} Z & 107° & \sin 9.981 \\ h & 38° & \cos 9.897 \\ \hline \end{array}$$

$$\text{sin } Z \cos h \log 9.878$$

Now suppose the observer estimates from the position of the body that its declination is 3° S. Look in the azimuth table on the page of latitude 5° (declination contrary name to latitude), and find the hour angle (p. m.) corresponding to Dec. 3° and Az. 107°; this is about $1^h 40^m$; then with $d=3°$, $t=1^h 40^m$, find sin $t$ cos $d$. (Sin $t$ may be obtained either by converting time into arc and taking from the table in the usual way, or by multiplying by 2 and finding it from the column headed "Hour P. M." Thus in the present case find the sine of 25° 00′ or of $3^h 20^m$. In using the time column be careful to take the name from the foot of the page when the double angle exceeds $6^h$.)

$$\begin{array}{lll} t & 1^h 40^m & \sin 9.626 \\ d & 3° & \cos 9.999 \\ \hline \end{array}$$

$$\text{sin } t \cos d \log 9.625$$

As this logarithm should equal 9.878, it is seen that the assumption is incorrect. Try a value of the declination 5° farther south—that is, 8° S. The corresponding hour angle is $2^h 50^m$.

$$\begin{array}{lll} t & 2^h 50^m & \sin 9.830 \\ d & 8° & \cos 9.996 \\ \hline \end{array}$$

$$\text{sin } t \cos d \log 9.826$$

The logarithm is not yet quite large enough; assume declination 10° S.; the hour angle is $3^h 20^m$.

$$\begin{array}{lll} t & 3^h 20^m & \sin 9.884 \\ d & 10° & \cos 9.993 \\ \hline \end{array}$$

$$\text{sin } t \cos d \log 9.877$$

This is practically identical with the logarithm of sin Z cos h, and the correct values are, therefore, $t=3^h 20^m$, $d=10°$ S.

We now have:

$$\begin{array}{llll} \text{G. S. T.} & 12^h & 53^m & \\ \text{Long.} & 2 & 53 & \text{W.} \\ \hline \text{L. S. T.} & 10 & 00 & \\ \text{H. A.} & 3 & 20 & \text{E.} \\ \hline \text{R. A.} & 13 & 20 & \end{array}$$

From the Nautical Almanac it is found that the right ascension of Spica is $13^h 19^m$ and the declination 10° 32′ S. This is therefore the body observed.

EXAMPLE: March 18, 1879, in Lat. 26° S., Long. $5^h 42^m$ E., by D. R., the altitude of a body is 41° and its azimuth S. 84° E., the Greenwich sidereal time being $10^h 52^m$. Required the name of the body.

$$\begin{array}{lll} Z & 84° & \sin 9.998 \\ h & 41° & \cos 9.878 \\ \hline \text{sin } Z \cos h \log 9.876 \end{array}$$

Assume first an hour angle of $3^h 00^m$. The corresponding declination is 23° (same name as latitude).

$$\begin{array}{lll} t & 3^h 00^m & \sin 9.849 \\ d & 23° & \cos 9.964 \\ \hline \text{sin } t \cos d \log 9.813 \end{array}$$

Next assume an hour angle of $3^h 30^m$. The declination is then 21° S.

$$\begin{array}{lll} t & 3^h 30^m & \sin 9.899 \\ d & 21° & \cos 9.970 \\ \hline \text{sin } t \cos d \log 9.869 \end{array}$$

Assume hour angle $3^h\ 35^m$.   Declination is still nearest to 21° S

$$
\begin{array}{lll}
t & 3^h\ 35^m & \sin\ 9.907 \\
d & 21° & \cos\ 9.970 \\
\sin t \cos d & & \log\ 9.877
\end{array}
$$

The last assumption is therefore correct.
We then have:

$$
\begin{array}{lrl}
\text{G. S. T.} & 10^h & 52^m \\
\text{Long.} & 5 & 42\ \text{E.} \\
\hline
\text{L. S. T.} & 16 & 34 \\
\text{H. A.} & 3 & 35\ \text{E.} \\
\text{R. A.} & 20 & 09
\end{array}
$$

As there is no fixed star corresponding to these coordinates the tables for the planets should be consulted. On March 18, 1879, the right ascension of Mars is $20^h\ 09^m$, and the declination 21° 06′ S. This is therefore the body that was observed.

**404.** The following is a summary of the method employed:

1. Reduce time of observation to Greenwich sidereal time and find the true altitude to the nearest degree. (These operations must be performed before any sight can be worked; they are, therefore, not strictly a part of the process of identification.)

2. Correct the observed azimuth for deviation and variation.

3. Find the logarithm of sin Z cos $h$ to the third place.

4. Assume a declination and find the corresponding hour angle that will produce the given azimuth at the given latitude; or assume an hour angle and find the corresponding declination. (Use an azimuth table or diagram for the purpose.)

5. Find the logarithm of sin $t$ cos $d$ to the third place.

6. Observe whether this agrees with the logarithm of sin Z cos $h$, and if it does not, repeat trials until an agreement is found.

7. Having found the hour angle and declination, convert the Greenwich sidereal time into local sidereal time and subtract the hour angle if west, or add it if east; the result is the right ascension of the observed body, by which, with the declination and magnitude, the identification is accomplished.

**405.** The exactness with which the comparison of logarithms is carried out will depend upon the possibility of errors of identification in the region of the heavens involved. It will not usually be necessary to find the correspondence as closely as has been done in the examples given, and the cases will be rare when, with a fair estimate of hour angle or declination at beginning, a sufficiently accurate knowledge of the values can not be arrived at after the second approximation; and frequently the first will suffice for identificaton.

**406.** VALUE OF THE MOON IN OBSERVATIONS.—Next to the sun, the most conspicuous body in the heavens is the moon, and it may therefore frequently be employed by the mariner with advantage. Owing to its nearness to the earth and the rapidity with which it changes right ascension and declination, the various corrections entailed render observations of this body somewhat longer to work out, with consequent increased chances of error; and errors in certain parts of the work will have more serious results than with other bodies; the navigator will therefore usually pass the moon by if a choice of celestial bodies is offered for a determination of position; but so many occasions present themselves when there is no available substitute for the moon that the extra time and care necessary to devote to it are well repaid. During hours of daylight it is often clearly visible, and its line of position may cut with that of the sun at a favorable angle, giving a good fix from two observations taken at the same time, when the only other method of finding the position would be to take two sights of the sun separated by a time interval in which an imperfect allowance for the true run intervening would affect the accuracy of the result, or a clouding-over of the heavens would prevent any definite result whatever being reached; and during the night, the gleam upon the water directly below the moon may define the horizon and give opportunity for an altitude of that body when it is impossible to take an observation of any other. Navigators are therefore recommended to make use of the moon with complete confidence whenever it will serve their purposes. It has been the purpose of this work to point out the features of the various sights wherein the practice with the moon differs from that of the sun, stars, or planets; care and intelligent consideration will render these quite clear.

Besides its availability for determining Sumner lines of position, which it shares with other bodies, the moon affords a means for ascertaining the Greenwich mean time independently of the chronometer, thus rendering it possible to deduce the longitude and chronometer error. This is accomplished by the method of lunar distances, which is fully explained in Appendix V. If the Greenwich time given by an observation of lunar distance could be relied upon for accuracy, the method would be a great boon to the navigator; but this is not the case. The most practiced observer can not be sure of obtaining results as close as modern navigation demands, and the errors to which the method is subject are larger than the errors that may be expected in the chronometer, even when the instrument is only a moderately good one and its rate is carried forward from a long voyage. The method is not, therefore, recommended for use except where the chronometer is disabled or where it is known to have acquired some extraordinary error; and when lunar distances are resorted to care must be taken to navigate with due allowance for possible inaccuracy of the results. In this connection it is appropriate to say that the best safeguard against the dire consequences that may result from a disabled or unreliable chronometer is for every vessel to carry two—or, far better, three—of those instruments, the advantages of which plan are stated in article 265, Chapter VIII.

**407.** EMPLOYMENT OF BODIES DEPENDENT UPON THEIR POSITION.—The practical navigator will soon observe that there are certain conditions in which bodies are especially well adapted for the finding of latitude, and others where the longitude is obtained most readily.

Taking the sun for an example, when a vessel is on the equator and the declination is zero, that body will rise due east of the observer and continue on the same bearing until noon, when for an instant it will be directly overhead, with a true altitude of 90°, and will then change to a bearing of west, which it will maintain until its setting.    In such a case any observation taken throughout the day will give a true north-and-south Sumner line, defining longitude perfectly, but giving no determination of the latitude, excepting for a moment only when the body is on the meridian.    With the exception noted, all efforts to determine the latitude will fail.    The reduction to the meridian takes the form $\frac{0}{0}$, becoming indeterminate, and in the $\varphi'\ \varphi''$ sight the cosine of $\varphi'$ will assume a value that corresponds alike to any angle within certain wide limits—the limits within which the circle of equal altitude has practically a north-and-south direction.    In conditions approximating to this we may obtain a longitude position more easily than one for latitude, even within a few minutes of noon.

As the latitude and declination separate, conditions become more favorable for finding latitude and less so for longitude; the intermediate cases cover a wide range, wherein longitude may be well determined by observations three to five hours from the meridian, and latitude by those within two hours of meridian passage.    As extreme conditions are approached the accuracy of longitude determinations continues to decrease; at a point in 60° north latitude, when the sun is near the southern solstice, its bearing differs only 39° from the meridian at rising; or, in other words, even if observed at the most favorable position, the resulting Sumner line is such that 1' in latitude makes a difference of 1.3 miles of departure, or 2'.6 of longitude, and is far better for a latitude determination than for longitude.    And in higher latitudes still this condition is even more marked.

Having grasped these general facts, the navigator must adapt his time for taking sights to the circumstances that prevail, and when the sun does not serve for an accurate determination of either latitude or longitude the ability to utilize the stars, planets, and moon as a substitute will be of the greatest advantage.

**408.** Use of Various Sights.—Having taken a sight, the navigator may sometimes be in doubt as to the best method of working it.    No rigorous rules can be laid down, and experience alone must be his guide.    In a general way it may be well, when the body is nearer to the prime vertical than to the meridian, to work it for longitude, assuming latitude, and using the time sight; and when nearer the meridian to work it for latitude, assuming longitude, by the $\varphi'\ \varphi''$ method.    The time sight is more generally used than the other, it has wider limits of accurate application and is probably a little quicker; but as the meridian is approached and the hour angle decreases small errors in the terms make large ones in the results.    The $\varphi'\ \varphi''$ or latitude method should not ordinarily be employed beyond three hours from the meridian, and then only when the body is within 45° of azimuth from the meridian and has a declination of at least 3°; with an hour angle of $6^h$ (90°) or a declination of 0° the trigonometric functions assume such form that the method is not available; nor does it give definite results when the azimuth is 90° or thereabouts.

When the body is close enough to the meridian for the method of reduction to the meridian to be applicable, that method is to be preferred because of its quickness and facility.    It should be noted, however, that, though close enough to employ the reduction, it may not be sufficiently correct to assume that the body bears due north or south, and the sight should be worked with two longitudes, or the Sumner line determined by the azimuth, unless the bearing nearly coincides with the direction of the meridian.

In cases where a body transits near the zenith, a good fix both in latitude and longitude may be obtained by sights, a few minutes apart, near its meridian passage.    Various special methods have been devised for doing this, but it seems simpler to treat the problem as an ordinary one for Sumner lines, except where it falls within the narrow limits of application of the equal altitude method (art. 352, Chap. XIII).    The solution is possible, because in the condition where it is available (that of a high transit) the body makes a very rapid change of azimuth (from nearly east to nearly west) in a short space of time, and two observations separated by a short interval give Sumner lines that cut at a favorable angle.    The time sight or latitude sight may be used according as the body's bearing is greater or less than 45° from the meridian.    If one observation be taken when the bearing is about SE. and the other when it is about SW., the intersection, allowing for intervening run, will not only give the longitude, but will also afford a good check upon the meridian observation for latitude, which, in the case of high transits, it is difficult to make with perfect accuracy.

**409.** Working to Seconds and Accuracy of Determinations.—The beginner who seeks counsel from the more experienced in matters pertaining to navigation will find that he receives conflicting advice as to whether it is more expedient to carry out the terms to seconds of arc, or to disregard seconds and work with the nearest whole minute.

It is a well-recognized fact that exact results are not attainable in navigation at sea; the chronometer error, sextant error, error of refraction, and error of observation are all uncertain; it is impossible to make absolutely correct allowance for them, and the uncertainty increases if the position is obtained by two observations taken at different times, in which case an exactly correct allowance for the intervening run of the ship is an essential to the correctness of the determination.    No navigator should ever assume that his position is not liable to be in error to some extent, the precise amount depending upon various factors, such as the age of the chronometer rate, the quality of the various instruments, the reliability of the observer, and the conditions at the time the sight was taken; perhaps a fair allowance for this possible error, under favorable circumstances, will be 2 miles; therefore, instead of plotting a position upon the chart, and proceeding with absolute confidence in the belief that the ship's position is on the exact point, one may describe, around the point as a center, a circle whose radius is 2 miles—if we accept that as the value of the possible error—and shape the future courses with the knowledge that the ship's position may be anywhere within the circle.

It is on account of this recognized inexactness of the determination of position that some navigators assume that the odd seconds may be neglected in dealing with the different terms of a sight; the average possible error due to this course is probably about one minute, though under certain conditions it may

be considerably more. It is possible that, in a particular case, the error thus introduced through one term would be offset by that from others, and the result would be the same as if the seconds had been taken into account; but that does not affect the general fact that the neglect of seconds as a regular thing renders any determination liable to be in error about one minute. Those that omit the seconds argue, however, that since, in the nature of things, any sight may be in error two minutes, it is immaterial if we introduce an additional possibility of error of one minute, because the new error is as liable to decrease the old one as to increase it; but the fallacy of the argument will be apparent when we return to the circle drawn around our plotted point. The eccentricity of the sextant may exactly offset the improper allowance for refraction, and the mistake in the chronometer error may offset the observer's personal error, but unless we know that such is the case—which we never can—we have no justification for doing otherwise than assume that the ship may be any place within the 2-mile circle. If, now, we increase the possible error by 1 mile, our radius of uncertainty must be increased to 3 miles, and the diameter of the circle, representing the range of uncertainty in any given direction, is thereby increased from 4 to 6 miles.

It is deemed to be the duty of the navigator to put forth every effort to obtain the *most probable* position of the ship, which requires that he shall eliminate possible errors as completely as it lies within his power to do. By neglecting seconds he introduces a source of error that might with small trouble be avoided. This becomes of still more importance since modern instruments and modern methods constantly tend to decrease the probability of error in the observation, and to place it within the power of the navigator to determine his ship's position with greater accuracy.

**410.** There is a more exact way of defining the area of the ship's possible position than that of describing a circle around the most probable point, as mentioned in the preceding article, and that is to draw a line on each side of each of the Sumner lines by which the position is defined, and at a uniform distance therefrom equal to the possible error that the navigator believes it most reasonable to assume under existing conditions; the parallelogram formed by these four auxiliary lines marks the limit to be assigned for the ship's position; this method takes account of the errors due to poor intersections, and warns the navigator of the direction in which his position is least clearly fixed and in which he must therefore make extra allowance for the uncertainty of his determination.

It must be remembered in this connection that no position can ever be obtained except from the intersection of two Sumner lines, whether or not the lines are actually plotted; thus, a meridian altitude gives a Sumner line that extends due east and west, and a sight on the prime vertical a line that extends north and south, though it may not have been considered necessary to work the former with two longitudes or the latter with two latitudes.

**411.** THE WORK BOOK AND FORMS FOR SIGHTS.—The navigation work book, or sight book, being the official record of all that pertains to the navigation of the ship when not running by bearings of the land, should be neatly and legibly kept, so that it will be intelligible not only to the person who performed the work, but also to any other who may have reason to refer to it.

Each day's work should be begun on a new page, the date set forth clearly at the top, and preferably, also, a brief statement of the voyage upon which the ship is engaged. It is a good plan to have the dead reckoning begin the space allotted for the day, and then have the sights follow in the order in which taken. The page should be large enough to permit the whole of any one sight to be contained thereon without the necessity of carrying it forward to a second page. No work should be commenced at the bottom of a page if there is not room to complete it. Every operation pertaining to the working of the sights should appear in the book, and all irrelevant matter should be excluded.

It is well to observe a systematic form of work for each sight, always writing the different terms in the same position on the page; this practice will conduce to rapidity and lessen the chances of error. In order to facilitate the adoption of such a method, there are appended to this work (Appendix II) a series of forms that are recommended for dead reckoning, and for time sights, meridian altitudes, and latitude sights (both by $\varphi'$ $\varphi''$ formula and method of reduction to the meridian), for the sun, stars, planets, and moon, respectively. For beginners, these are deemed of especial importance, and it is recommended that, until perfect familiarity with the different sights is acquired, the first step in working out an observation be to write down a copy of the appropriate blank form, indicating the proper sign of application of each quantity (for which the notes will be a guide), and not to put in any figures until the scheme has been completely outlined; then the remainder of the work will consist in writing down the various quantities in their proper places and performing the operations indicated.

# CHAPTER XVII.

## MARINE SURVEYING.

**412.** DEFINITIONS.—*Surveying* is the art of representing upon paper the surface of the earth, giving its characteristic features, such as, on land, the position of prominent objects, heights, and depressions, and on water, the depth, character of bottom, and position of shoals.

*Topographical Surveying* delineates the land, and *Hydrographic Surveying*, the water.

*Geodesy* is a higher kind of surveying, which takes into account the curvature of the earth. To points determined by a geodetic survey other surveys are referred.

It is not deemed appropriate to include in this work a complete treatise on Marine Surveying. The scope of this chapter will be to set forth such general information regarding the principles of surveying and the instruments therein employed as will give the navigator an intelligent understanding of the subject sufficient to enable him to comprehend the methods by which marine charts are made, and, if occasion should arise, to conduct a survey with such accuracy as the instruments ordinarily at hand on shipboard may permit. For a more detailed discussion of Marine Surveying, the student is referred to the various publications which treat the subject exhaustively.

### INSTRUMENTS EMPLOYED IN MARINE SURVEYING.

**413.** THE THEODOLITE AND TRANSIT.—The *Theodolite* (fig. 54) is an instrument for the accurate measurement of horizontal and vertical angles. While these instruments vary in detail as to methods of construction, the essential principles are always identical.

A telescope carrying crosshairs in the common focus of the object-glass and eyepiece is so mounted as to have motion about two axes at right angles to one another; graduated circles and verniers are provided by which angular motion in azimuth and (usually) in altitude may be measured; and the instrument is capable of such adjustment by levels that the planes of motion about the respective axes will correspond exactly with the horizontal and the vertical.

The telescope is carried in appropriate supports upon a horizontal plate which has, immovably attached to it, one or more verniers, and which revolves just over a graduated circle that is marked upon the periphery of a second horizontal plate, a means of measuring the motion of the upper plate relatively to the lower one being thus provided. Thumb-screws are fitted by which the upper plate may be clamped to the lower, and (excepting in some simpler forms of the instrument) others by which the lower plate may be made immovable in azimuth, or allowed free motion, at will; all clamping arrangements include slow-motion tangent-screws for finer control.
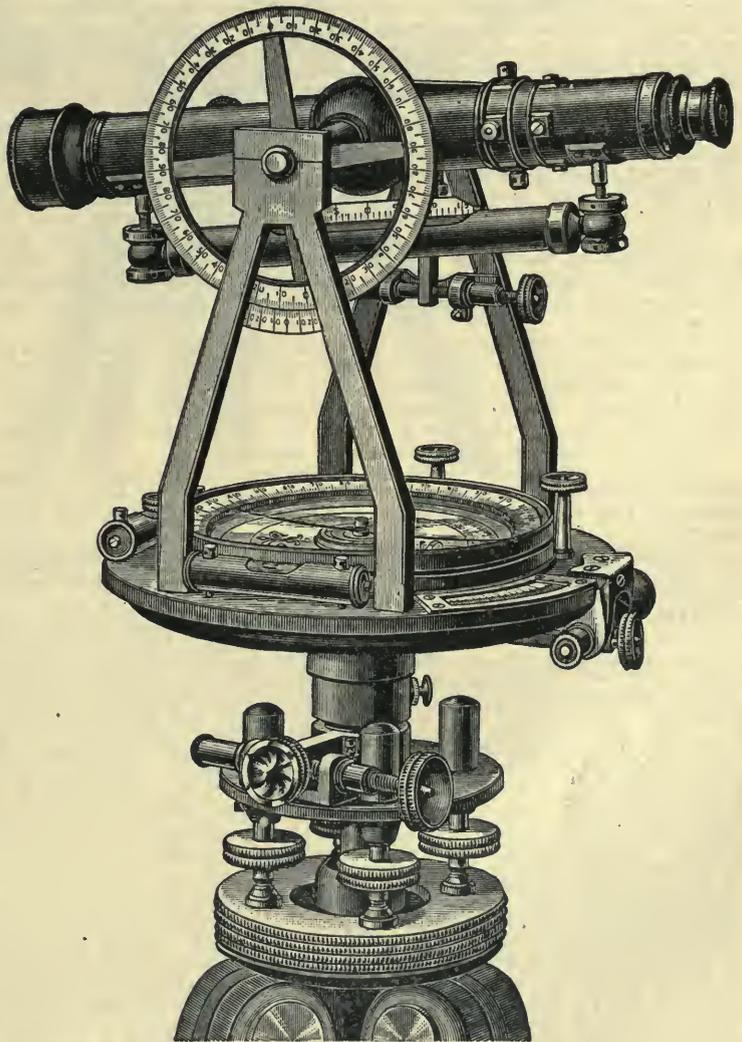
FIG. 54.

A vertical graduated circle, or arc, with a vernier, clamps, and tangent-screws, is fitted to most theodolites, for the measurement of the angular motion of the telescope in altitude.

The theodolite usually carries a magnetic needle, with a graduated circle and vernier for compass bearings. The instrument is mounted upon a tripod, and levels and leveling-screws afford a means of bringing the instrument to a truly horizontal position.

The *Transit* used in surveying is a modified form of the theodolite, and is generally employed where less accuracy is required; it takes its name from the fact that the telescope may be turned completely about its horizontal axis, or *transited*, without removal from its supports.

**414.** The *line of collimation* of a telescope is an imaginary line passing through the optical center of the object-glass in a direction at right angles to that of its axis of rotation. This is also called the *axis of collimation*. The *line of sight* is an imaginary line passing through the optical center of the object-glass and the point of intersection of the cross-hairs.

A theodolite or transit, before it can be used for the accurate measurement of angles, must be in adjustment in the following respects: (*a*) The vertical axes of revolution of the upper and lower horizontal plates must be coincident; (*b*) the axis must be vertical and the plates horizontal when the bubbles of the levels are in their central positions; (*c*) the vertical cross hair must be perpendicular to the horizontal axis of the telescope; (*d*) the line of collimation must coincide with the line of sight; (*e*) the horizontal axis of the telescope must be perpendicular to the vertical axis of the instrument; (*f*) the bubble of the telescope level must stand at the middle of its scale, and the vertical circle must read zero, when the line of collimation is horizontal.

The last-named condition may be disregarded if vertical angles are not to be measured.

**415.** The instrument being in adjustment, to observe angles it should be set up, leveled, and focused. This involves placing the tripod so that a plumb bob from the center of the instrument shall hang directly over the spot at which the measurement is to be made. The legs of the tripod should be firmly placed in such manner that the height shall be convenient for the observer and the instrument shall be nearly level. Then the horizontal plates are brought to a true level by means of the leveling screws and bubbles. The telescope should next be focused by moving the object glass and eyepiece in such manner that the object sighted and the cross hairs may be plainly seen and that the object will not appear to have motion relatively to the cross hairs as the eye is moved to the right or left in front of the eyepiece. This last condition insures the cross hairs being at the common focus of the eyepiece and objective.

To observe a horizontal angle with a theodolite or transit, clamp the upper plate to the lower at zero, leaving the lower plate unclamped; swing the telescope so that its vertical cross hair bisects one of the objects, and clamp the lower plate; unclamp the upper plate and bring the telescope to bisect the other object, and the reading of the vernier on the scale will give the required angle. (The final nice motion by which the cross-hair is brought exactly upon a point is always given by the tangent screw.)

In taking a *round of angles*, this operation is repeated successively upon each object to be observed about the horizon, the upper plate being always swung, while the lower is kept where set upon the first object, or *origin*. The result will give the angular distance of each object from the origin, and, if the observations have been accurately made, upon finally sighting back to the origin, the reading should be zero.

To *repeat an angle*, having made the first measurement of it in the usual way, unclamp the lower circle and swing back the telescope until it again points to the first object, and clamp it; then unclamp the upper circle, swing to the second object, and clamp. The scale-reading should now be double that of the first angle. Repeat as often as the importance of the angle requires, and the accepted value will be the final reading divided by the number of measurements. All angles of the main triangulation, and others of importance in the survey, are repeated.

Defects in adjustment of the instrument may be eliminated by taking one series of angles with the *telescope direct* and another with the *telescope reversed*. To reverse the telescope, revolve it about its horizontal axis through 180°, then swing it about its vertical axis through 180°—in other words, invert it.

Vertical angles are measured on the same principle as that described for horizontal ones.

The process of setting up the instrument at a station and observing the angles between the various objects that are visible is called *occupying* the station.

**416.** THE PLANE TABLE.—This is an instrument by which positions are plotted in the field directly upon a working sheet. It consists (fig. 55) of a drawing board mounted upon a tripod in such manner as to be capable of motion in azimuth, and with facilities for being brought to a perfect level; in connection with it is employed an alidade, consisting of a straightedge ruler, upon which is mounted a telescope with cross-hairs whose line of sight is exactly parallel to the vertical plane through the edge of the rule. It is evident that if a sheet representing a chart be placed upon such a board and turned so that the true meridians, as portrayed thereon, lie in the direction of the earth's meridian at that place, then all lines of bearings on the chart will coincide with the corresponding lines on the earth's surface; from which it follows that if the alidade be so placed that its rule passes through the spot on the chart representing the position of the observer, while the telescope is directed to some visible object, the position of that object on the chart lies somewhere upon the line drawn along the edge of the rule. Upon this general principle depend the various applications of the plane table.

The drawing board is usually made of several pieces of well-seasoned wood, tongued and grooved together, with the grain running in different directions to prevent warping; about its edge are several metal clips for securing the paper in place. It is supported upon three strong brass arms, to which it is attached by screws, thus permitting its removal at will. The arms are attached to a horizontal plate which revolves upon a second horizontal plate lying immediately below it; a clamp and tangent screw are fitted, by which the upper plate, and with it the drawing board, may be secured to the lower plate, or may be given a fine motion in azimuth. Three equidistant lugs of brass, grooved on the under side, project down from the lower plate, resting on screws in the top of the tripod, by which the instrument is leveled; when adjusted in this respect it is firmly clamped in position, and, as the tripod is made unusually large, the adjustment is not easily deranged.

The alidade is a metal straightedge with a vertical column at its center, at the top of which are the supports which carry the telescope; a vertical arc and vernier are provided for measuring the motion of the telescope in altitude. The telescope is usually so fitted that it may be revolved in azimuth through an arc of exactly 180°, for the purpose of adjusting the line of collimation. On top of the rule near its center is the level—sometimes replaced by two levels at right angles—by means of which it may be seen when the table is in a true horizontal position.

A magnetic needle mounted in a rectangular metal box, whose outer straightedge is parallel to the zero line of a graduated scale over which the needle swings, is provided for drawing the north-and-south line on the chart; this is called a *declinatoire*.
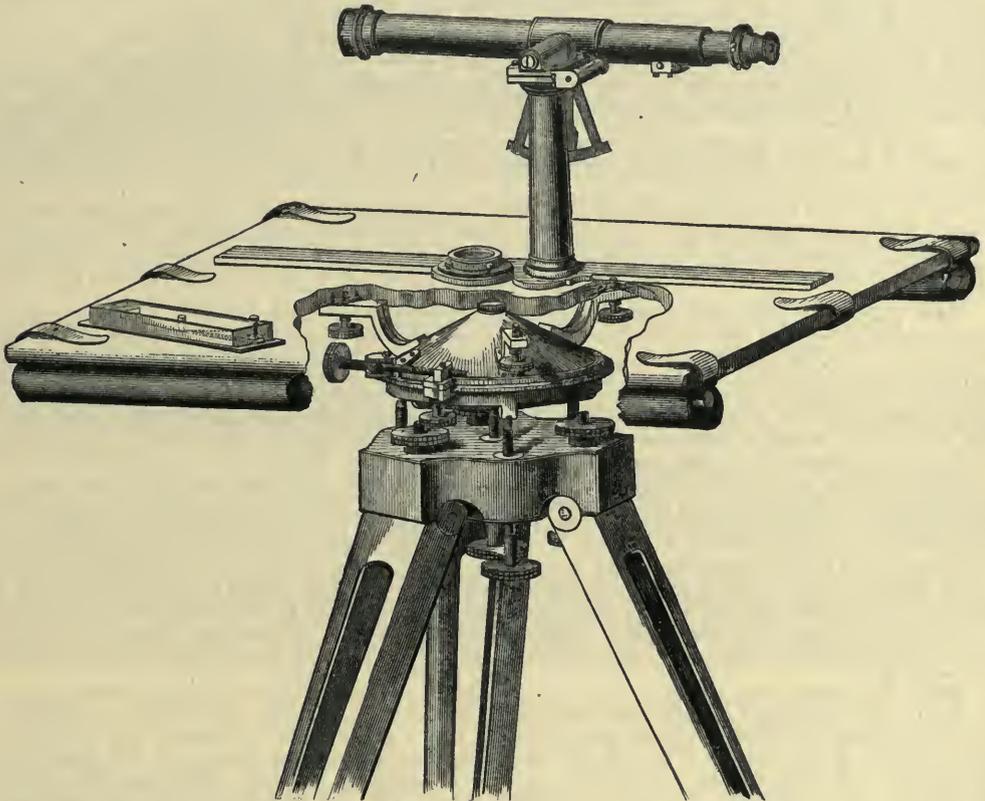


Fig. 55.

**417.** To be in correct adjustment, a plane table must comply with the following conditions:

(a) The fiducial edge of the rule must be perfectly straight. (b) The level must have the bubble in its central position when the table is truly horizontal. (c) The vertical cross hair must be perpendicular to the horizontal axis of the telescope. (d) The line of collimation must coincide with the line of sight. (e) The horizontal axis of the telescope must be parallel to the plane of the table. (f) The vertical circle should read zero when the line of collimation is horizontal.

**418.** The results derived from the use of the plane table, like all others dependent upon graphic methods, must be regarded as less accurate than those deduced by computation, and even less accurate than those derived from the careful plotting of theodolite angles. Hence it is that, in a careful marine survey, this instrument would be employed only for the topography and shore line.

For whatever purpose used, the plane table would not ordinarily be called into requisition until the survey had so far progressed that a chart could be furnished the observer showing certain stations whose positions were already established; with this chart, the first step would be to *occupy* one of the determined points. The table must be set up with the point on the chart directly over the center of the station; it must then be leveled and the telescope focused as described for the theodolite or transit; and finally it must be *oriented*, that is, so turned in azimuth that all lines of the chart are parallel to similar lines of the earth's surface. To orient, unclamp the table and swing it until the north-and-south line of the chart is approximately parallel to that of the earth, one means of doing which is afforded by the declinatoire; place the alidade so that the edge of the rule passes through the points on the chart representing the station occupied and some second station which is clearly in view; then, sighting through the telescope, perfect the adjustment of the table by swinging it until the second station is exactly bisected by the vertical cross hair, the final slow motion being obtained by clamping the table and working the tangent screw. If the adjustment has been correctly made, the rule may be laid along the line joining the station occupied and any other on the chart, and the telescope will point exactly to that other station.

Being properly oriented, if the alidade be so placed that the edge of the rule pass through the station occupied, and the telescope point directly to some unknown object whose position is to be determined,

then a line drawn along the rule will contain the point which represents the position of that object. If, now, the plane table be set up at a second station, oriented for its new position, and a line be similarly drawn from that station toward the one to be established, it will intersect the first line in the required point. This is the method of determining positions by *prosection*. Actually, the surveyor does not regard the point as well established until the intersection is checked by a line from a third station.

In practical work, of course, each station is not occupied separately for the determination of each point; the instrument is set up at a station, lines are drawn to all required points in view, and each line is appropriately marked; then a second station is occupied, and the operation repeated, and so on, the various intersections being marked as the work proceeds.

A second method of establishing positions is that of *resection;* in this the first line is drawn from some known station, as in the preceding method, and the observer next proceeds to the place whose position is required and occupies it; the plane table is there oriented by means of the line already drawn, placing the edge of the rule along the line, sighting back toward the first station, and swinging the table until that station is in the line of sight of the telescope; then choose some other established station as nearly as possible at right angles to the direction of the first; place the edge of the rule upon the plotted position of this station and swing the alidade (the rule always being kept on the plotted point) until the object is bisected by the telescope cross-hairs; draw this line, and its intersection with the first will give the required point, the accuracy of which can be checked from some other plotted station.

A third method of locating a point is by means of a single bearing from a known station, with the distance from the occupied station to the required one, the process of plotting being self-evident.

A fourth method is given by occupying an undetermined position from which three established stations are in view; the point occupied by the observer is then plotted by an application of the "three-point problem."

**419.** It may be seen that where the greatest accuracy is not essential the plane table may be employed for plotting all the points of a survey. In such a case it would only be necessary to begin with the two base stations, plotted on the sheet on any relative bearing whatsoever and at a distance apart equal to the length of the base line (reduced to scale), as measured by the most accurate means available. The work of plotting might even proceed before the base line had been measured, the two stations being laid off at any convenient distance apart; when, later, the base line was measured, the scale of the chart would be determined, being equal to the distance on the chart between base stations divided by the length of the base line.

**420.** A plane table could be improvised on shipboard which would greatly facilitate the operation of any surveying work that a vessel not equipped with instruments might be called upon to perform. A drawing board could be mounted upon a tripod (as, for example, the tripod supplied for compass work on shore) in such manner as to be capable of motion in azimuth; it could be brought nearly to the horizontal, if no better means offered, by moving the tripod legs, and this adjustment could be proved by any small spirit level; sight vanes could be erected upon an ordinary ruler to take the place of the alidade; in case there was difficulty in observing any object with such an alidade, because of its altitude or for other reasons, a horizontal angle might be observed with a sextant and plotted with a protractor. By this means work could be done which, even if it should lack complete accuracy, might be of great value.

**421.** The Telemeter and Stadia.—Any telescope fitted with a pair of horizontal cross-hairs at the focus may be used as a *telemeter*, and when accompanied by a graduated staff, called a *stadia*, affords a means of measuring distance (up to certain limits) with a close degree of accuracy; the method consists in observing the number of divisions of the scale subtended by the hairs when the stadia is held up vertically and perpendicular to the line of sight of the telescope, it being evident that the closer the distance the fewer divisions will appear between them. The facility with which distances can be measured by this method makes it most important that all telescopes of theodolites, transits, and plane tables be fitted as telemeters, and that stadia rods be provided for all surveying work.

Speaking approximately, it may be said that the number of divisions intercepted between the cross-hairs will vary directly as the distance of the stadia rod. This would be exactly true if we looked at the object through an empty tube, directly between the hairs. Since, however, the rays from the stadia are refracted by the object glass before they are intercepted by the wires, the statement, to be absolutely exact, must be slightly modified; but for practical surveying work it may be accepted as given.

**422.** There are two methods of installing the telemeter cross-hairs—the first, in which they are immovably secured in the telescope and always remain at the same distance apart, and the second, in which the distance of the cross hairs is made variable, being under the control of the observer. The former is generally regarded as the preferable method, and when it is employed it is evident that the subtended height of the stadia bears a constant ratio to the distance of the staff from the telescope. It proves most convenient in practice to space the hairs so that this constant ratio is some even multiple of 10, for facility in converting scale readings into distance; it is also advantageous to mark the stadia in the unit of the chart scale and decimals thereof; for example, if the ratio of stadia height to distance were 100, and the stadia were marked in meters and decimals, a reading of 2.07 would at once be converted into a distance of 207 meters. Any units and any ratio may, however, be employed, and for any given setting of cross-hairs it is very easy to graduate a stadia, by experiment, for any desired units; for example, if it is required to mark the stadia in feet, set up and level the telescope, measure off a distance of exactly 100 feet from it, hold up an unmarked staff and mark upon it the points intersected by the cross hairs; the interval between these marks will represent 100 feet of the scale; divide this length into 100 parts, each of which will represent a distance of one foot, and mark the whole staff on the same scale; then if the stadia be held up at any distance, the cross-hairs will intercept a number of divisions corresponding to the number of feet of distance.

When the cross-hairs are movable the ratio becomes variable, but the principle of measuring remains the same—namely, the distance of the staff from the telescope is equal to the existing ratio multiplied by the distance intercepted on the scale.

**423.** The stadia is made of a light, narrow piece of wood and is usually hinged for convenience in transporting. Ordinarily the background of the scale is painted white, while the main divisions are marked in red, with minor divisions in black, and geometrical figures are employed to facilitate the reading of fractional parts of the scale. Devices are furnished by which the man holding the stadia may know when it is at right angles to the line of sight of the telescope—an essential condition for accuracy of measurements.

**424.** The use of the telemeter and stadia for measuring distances is limited to the distance at which the scale divisions can be accurately read through the telescope. For fairly close work and with the class of telescope usually supplied with surveying instruments, 400 meters represents about the greatest distance at which it can be employed. With this limitation, the character of the survey determines the nature of its employment. In a careful survey its greatest use would be in connection with the theodolite or plane table in putting in shore lines, contour lines, and topography generally. In a survey where only approximate results are sought it might afford the best means for the measurement of the base.

**425.** If the telemeter be applied to a theodolite, transit, or plane table which is fitted with a graduated vertical arc or circle, it is possible to measure the distance to the stadia not only in a horizontal but also in a vertical direction. In this case the vertical angle must be observed as well as the stadia reading. Tables are computed giving the solution of the triangles involved.

**426.** In making a survey with the ordinary resources of a ship, the principle of the telemeter and stadia may be profitably employed, using a sextant and improvised staff. In this case it is usual to have the stadia of some convenient fixed length, as, for example, 10 feet, and of slight width and thickness; this is held at right angles to the line of sight from the observer, who notes the angle subtended by the total length; tables are prepared by which the distance corresponding to each angle is given.

**427. THE SEXTANT.**—This instrument is of the greatest value in hydrographic surveying. It is fully described elsewhere in this work and its adjustment explained (Chap. VIII).

Sextants are manufactured of a form especially adapted to surveying work; they are smaller and lighter than those usually employed in astronomical observations, but have a longer limb, by which angles may be measured up to 135°; the vernier is marked for quick reading and has no finer graduation than half minutes; the telescope has a large field.

This instrument is principally employed in measuring the horizontal angles by means of which soundings are plotted. It may, however, be put to various uses when making an approximate survey, as has already been explained. It should be remembered, in measuring terrestrial angles with a sextant, that rigorous methods require a reduction to the horizontal if either of the objects has material altitude above the horizon.

**428. THE LEVEL.**—This is an instrument for the accurate measure of differences of elevation. It consists of a telescope, carried in a Y-shaped rest, which is mounted upon a tripod and leveled in a manner similar to a theodolite; but it differs from that instrument in that the telescope is not capable of motion about a horizontal axis, and in having no graduated circle for measurements of altitude and azimuth. The principle of its use contemplates placing the line of collimation of the telescope in a truly horizontal plane and keeping it so fixed.

**429.** It is principally employed in marine surveying to determine heights and contour lines—the latter being lines of equal elevation above the sea level—and for locating bench marks for tidal observations (Chap. XX). In connection with it is used a graduated staff called a *leveling rod*, carrying a conspicuous mark, adjustable in height, called a *target*. To ascertain the difference of level between any two points, set up the level with the telescope horizontal at some place between them; let an assistant take the leveling rod to one of the points, and, while holding it on the ground in a truly vertical position, move the target, under the direction of the observer at the telescope, to a point where it is exactly bisected by the horizontal cross-hair; the height of the target on the staff—that is, the height of the cross-hair above the level of the first point—is then accurately read with a vernier; now, without moving the level, shift the rod to the second point and again adjust the target and read it. It is evident that a comparison of the reading at the first position with that at the second will give the difference of height at the two points. The difference that can be read from one location of the instrument is limited by the length of the rod; but by making a sufficient number of shifts any difference may be measured.

The work of the level may be performed equally well by a theodolite whose telescope is adjusted to the true horizontal.

**430. HELIOTROPE AND HELIOGRAPH.**—These are instruments sometimes employed in surveying, by means of which the sun's rays may be reflected in any given direction; the object of their use is to render conspicuous a station which is to be observed at a distance and which would not otherwise be distinguishable. The instruments vary widely in form of construction and, in the absence of those made for the purpose, substitutes may easily be devised.

**431. ASTRONOMICAL TRANSIT INSTRUMENTS.**—Various instruments are employed for the astronomical determinations necessary in a marine survey. Among these are the *zenith telescope* and *portable transit*. While differing in detail they consist essentially of a telescope mounted upon a horizontal axis that is placed truly in the prime vertical, thus insuring the revolution of the line of collimation in the meridian; a vertical graduated circle and vernier are supplied, affording a measure of altitude; in the focus are a number of equidistant vertical cross-hairs or lines; a small lamp is so placed that its rays illuminate the cross-hairs and render possible observations at night. Latitude is obtained by observing the meridian altitude of stars; hour angle (and thence longitude) by observing the times of their meridian transit, which is taken from the mean of the times of passing all of the vertical cross-hairs.

Excepting in surveys of a most accurate nature, the astronomical determination of position by the sextant and artificial horizon is regarded as satisfactory.

**432.** The Three-Armed Protractor, or Station Pointer.—This is an instrument whereby positions are plotted on the principle of the "three-point problem," of which an explanation is given in article 152, Chapter IV. It consists (fig. 56) of a graduated circle with three arms pivoted at the center; each arm has one edge that is a true rule, the direction of which always passes through the center of the circle. The middle arm is immovably fixed at the zero of the scale; the right and left arms each revolve about the center on their own sides, and are provided with verniers giving the angular distance from the middle arm. The protractor being set for the right and left angles, it is so moved that the three arms pass through the respective stations, when the center marks the position of the observer. Center pieces of various forms are provided, being cylindrical plugs made to fit into a socket at the pivot, and by employing one or the other of them the true center may be pricked with a needle, dotted with a pencil, or its position indicated by cross-hairs. Adjustable arms are provided which can be fitted to the ends of the ordinary arms when working with distant signals.

The most valuable use of the three-armed protractor is in plotting the positions of soundings taken in boats, where sextant angles between signals are observed. It may occur, however, that certain shore stations will be located by its use.

**433.** In default of a three-armed protractor, a piece of *tracing paper* may be made to answer its purpose. To use the tracing paper, draw a line, making a dot on it to represent the center station, and with the center of an ordinary protractor on the dot, lay off the two observed angles right and left of the line; then, laying this on the plan, move it about till the three lines pass exactly through the three stations observed. The dot from which they were laid off will be on the position of the observer, and must be pricked lightly through or marked underneath in pencil.



Fig. 56.

**434.** The Beam Compass.—This instrument (fig. 57) is employed in chart drafting and performs the functions of compasses and dividers when the distance that must be spanned is beyond the limits of those instruments in their ordinary form. It consists of an angular bar of wood or metal upon which two instruments termed beam heads are fitted in such a manner that the bar may slide easily through them. A clamping screw attached to one side of the beam head will fix it in any part of its course along the beam. Upon each head a socket is constructed to carry a plain point, exchangeable for an ink or a pencil point. For exact purposes the beam head placed at the end of the beam has a fine adjustment, which moves the point a short distance to correct any error in the first rough setting of the instrument. This adjustment generally consists of a milled-head screw, which passes through a nut fixed upon the end of the beam head, which it carries with its motion.



Fig. 57.

**435.** Proportional Dividers.—These are principally employed for reducing or enlarging drawings in any given proportion. They consist (fig. 58) of two narrow flat pieces of metal called *legs*, which turn upon a pivot whose position is movable in the direction of their length. The ends of both legs are shaped into points like those of ordinary dividers. When the pivot is fixed at the middle of the legs, any distance measured by the points at one end is just equal to that measured by those at the other; for any other location of the pivot, however, the

distances thus measured will not be equal, but with a given setting of the pivot any distance measured by one end bears a fixed ratio to that measured by the other. The path of travel of the pivot is graduated so that the ratio may be given any desired value. Being adjusted in this respect, if a distance is taken off a chart with the legs at one end of the instrument, then those at the other end will show the same distance on the scale of a chart enlarged or reduced in the proportion represented by the ratio for which the pivot was set.

## METHODS EMPLOYED IN A HYDROGRAPHIC SURVEY.

**436.** A geodetic survey has for its object the determination, with the greatest attainable accuracy, of points on the surface of the earth, by the employment of a process of triangulation, all positions being located either trigonometrically or astronomically, and the curvature of the earth being taken into account.

Before commencing a survey a general inspection of the field is made; a *base line* is located and its extremities marked by *signals;* certain other positions, known as *main triangulation points,* are selected and also marked with signals, being so chosen that, starting with the base and proceeding thence from one to another of these points, a series of well-conditioned triangles or quadrilaterals may cover the field of survey. The base line is measured with the greatest degree of accuracy which the resources of the survey render possible. Each extremity of the base line and each other main triangulation point is occupied by an observer with a theodolite, who measures the angles at each station between all the other stations which are in sight. An *astronomical determination* is made of the latitude and longitude of some point of the survey (frequently one of the extremities of the base) and of the true azimuth of some known line (frequently the base line). Data is now at hand for the location upon the chart of the base line and main triangulation points.

If the survey is one of considerable extent it is expedient to measure a *check base* near the end of the triangulation, a comparison between the measured and the computed distance between any two stations showing the accuracy of the work and affording a means of reconciling discrepancies. The position of a second observation spot may be determined for a similar purpose.

The *primary triangulation* gives a skeleton of the field, but the points thus determined are not usually close enough together to afford a basis for all the detail work that must be done. A second system of points is therefore selected and signals erected thereon, and the position of these points is determined by a series of angles from the main triangulation points and from each other. This is known as the *secondary triangulation.* The points thus located are used in the plotting of the *topography* and *hydrography.* It is not essential that their determination be as accurate as that of main triangulation points.

The topography is put in, and includes the delineation of the features of the land—shore line, light-houses, beacons, contour lines, peaks, buildings, and, in short, everything that may be recognized by the navigator and utilized by him in locating the ship's position.

FIG. 58.

The hydrographic work is taken up and the depth of water and character of bottom determined as accurately as possible for the complete water area, especial care being taken to develop all shoals and dangers to navigation and to locate all aids to navigation, such as buoys, light-ships, and beacons.

One or more *tidal stations* are established where observations are taken, continually and at frequent intervals, of the height of the tide and direction and velocity of the tidal and other currents, whence data is derived for the reduction of all soundings to the plane of reference and for the information about tides and currents which is to appear upon the chart.

Observations are made to determine the *magnetic* variation and dip, and the intensity of the earth's magnetic force.

**437.** The foregoing represent, in outline, the various steps that must be taken in the accumulation of the data necessary for the construction of a complete hydrographic chart. In the following paragraphs the details of the various operations will be more fully set forth.

The navigator who is called upon to conduct a marine survey without having available the time, instruments, and general facilities necessary for the most thorough performance of the work must exercise his discretion as to the modifications of method that he will make, and call upon his ingenuity to adapt his means to the particular work in hand.

**438.** THE BASE LINE.—As the base line is the foundation for all distances on the chart, the correctness of the results of the survey will depend largely upon the degree of accuracy with which it is measured. The triangulation merely affords a measure of the various distances as compared with the distances between the two initial points from which it began; if that initial distance is 1,000 feet, we have certain values for the sides of the various triangles; if the same base line is 2,000 feet, the value of each side becomes twice as great as it was before; with the same triangulation, therefore, distances vary directly with the length of the base line; it may thus be seen that if an error exists in measurement which is only a small fraction of the total length, the error will become much more material as the more distant points of the survey are reached. In a base line 1,000 feet long, if a mistake of 10 feet be made, all distances measured upon the chart will be in error 1 per cent, and a point plotted by triangulation 10 miles from the observation spot (the point at which plotting begins), would be out of its correct position one-tenth of a mile.

It is important that the base line should be as long as possible, as an error in measurement will thus constitute a smaller percentage of the total length and will not accumulate so rapidly as the work proceeds. The position of the line must be such as to afford favorably conditioned triangles and quadri-

laterals with adjoining main triangulation points, and its extremities must be visible from those points and from each other.   The character of the ground and the facility for measuring will of course form an important consideration in the choice.

**439.** In measuring a base by tape, chain, or similar means, a number of successive fleets are made with the measure, whatever its nature, the distance traversed being appropriately marked after each fleet, while an observer, with a theodolite or transit, insures the measurement being made accurately along the line.

**440.** The most careful measurements are made by a steel tape 100 feet long, stretched along a series of battens which are supported by metal crutches and made exactly horizontal by a level.   The tape is stretched to a uniform tension by a spring balance; its exact length at that tension is known from comparison with some standard; a correction for temperature is applied.   The ends of the fleets are marked by driving into the ground a peg carrying in its top a tack; the exact end of the tape is marked by a score filed on the head of the tack at a point marked by a plumb bob from the tape, and this score becomes the origin for the next fleet.   An assistant precedes the measuring party before each shift of the battens, and is accurately aligned by the theodolite to mark the true direction of the base line.   The result of this method of measurement gives the *horizontal* distance between the points.   It can be depended upon for the greatest degree of accuracy of any method, excepting that with a special *base-measuring apparatus*, which is seldom employed in marine surveys.

**441.** A second method of base measurement is with the surveyor's chain.   This depends for accuracy upon the surface traversed being plane and level, a condition that is well fulfilled on a sandy beach, where the chain is nearly as accurate as the tape and much more rapid.   A surveyor's chain is usually 100 feet long; the exact value of its length must be obtained by comparison with a standard, and a correction applied for expansion or contraction due to temperature.   The ends of the fleets are marked by steel pins driven into the ground; the alignment is kept by the theodolite.

**442.** Where neither chain nor tape is available substitutes may be improvised from sounding wire taken from the deep-sea sounding machine, or, failing this, from well-stretched cod line.

**443.** Measurements made by the telemeter and stadia afford a close approximation to the true result, and if these instruments are not at hand the sextant angle of a rod of fixed length can be employed. The masthead height of the vessel may be used in determining the length of base line on this principle, either by making the ship itself mark one of the extremities and observing the masthead angle from the other extremity, or by simultaneously observing the masthead angle from both ends of a shore base, and also the three horizontal angles of the triangle formed by the ship and the two base stations. The latter plan is far preferable where accuracy is sought, as, if the angles are all taken by different observers at the same instant (which can be marked by the hauling down of a flag), the error arising from the motion of the ship about her anchor is eliminated, and, moreover, the data furnished offers a double solution of the triangle and the mean may be taken as giving a closer result.

**444.** A crude method of measuring a base is by means of the velocity of sound, though this would never be used where close results are expected.   Fire a gun at one end of the base and at the other note by the most accurate means available the time between seeing the flash and hearing the report. Repeat several times in each direction.   The mean number of seconds and tenths of a second multiplied by the velocity of sound per second at the temperature of observation (art. 314, Chap. XI) gives the approximate length of base line.

**445.** When for any reason the existing conditions do not permit of a direct measurement being made along the line between the two base stations, recourse must be had to a *broken base*, that is, one in which the length of the base is obtained by reduction from the measured length of two or more auxiliary lines.   Necessity for resorting to a broken base arises frequently when the two stations are situated on a curving shore line and the straight line between them passes across water, or where wooded or unfavorable country intervenes, or where a stream must be crossed.   The most common form of broken base is that in which the auxiliary lines run from each extremity of the base at an acute angle and intersect; in addition to measuring each of these lines, the angles of the triangle formed by them with the base line must be observed and the true length of the base deduced by solution of the triangle. The form that is most frequently used where only a short section of the base is incapable of measurement (as is the case where a deep stream flows across) is that of an auxiliary right triangle whose base is the required distance along the base line and altitude a distance measured along a line perpendicular thereto to some convenient point; by this measured distance and the angles which are observed, the triangle is solved and the length of the unmeasured section determined.

**446.** In a survey of considerable extent, where good means are at hand for the correct determination of latitude and longitude, a base line actually measured upon the earth may be dispensed with, and, instead of that, the positions of the two stations which are most widely separated may be determined astronomically and plotted; the triangulation is then plotted upon any assumed scale, and when it has been brought up to connect the two stations the true value of the scale is ascertained.   This is called the method of an *astronomical base*.

**447.** Signals.—All points in the survey whose positions are to be located from other stations, or from which other positions are to be located, must be marked by signals of such character as will render them distinguishable at the distance from which they are observed.   The methods of constructing signals are of a wide variety.

A vessel regularly fitted out for surveying would carry scantlings, lumber, bolts, nuts, nails, white-wash, and sheeting for the erection of signals; however meager the equipment, the whitewash and sheeting (or some substitute for sheeting, preferably half of it white and half dark in color,) should be provided, if possible, before beginning any surveying work.   Regular tripod signals, which are quickly erected and are visible, under favorable circumstances, for many miles, are almost invariably employed to mark the main triangulation stations; among other advantages the tripod form permits the occupation with the theodolite of the exact center of the station, and avoids the necessity for the reduction which must otherwise be applied.   Signals on secondary stations take an innumerable variety of forms, the require-

ment being only that they shall be seen throughout the area over which they are to be made use of; a whitewashed spot on a rock, a whitewashed trunk of a tree, a whitewashed cairn of stones, a sheeting flag, a piece of sheeting wrapped about a bush or hung, with stones attached, over a cliff, or a white-washed barrel or box filled with rocks or earth and surmounted by a flag, suggest some of the secondary signals that may be employed; sometimes objects are found that are sufficiently distinct in themselves to be used as signals without further marking, as a cupola or tower, a hut, a lone tree, or a bowlder; but it is seldom that an object is not rendered more conspicuous by the flutter of a flag above it, or by the dead-white ray reflected from a daub of whitewash.

For convenience, each signal is given some short name by which it is designated in the records.

**448.** The Main Triangulation.—The points selected as stations for the main triangulation mark in outline the whole area to be surveyed; they are close enough together to afford an accurate means of plotting all intermediate stations of the secondary triangulation; and they are so placed with relation to one another that the triangles or quadrilaterals derived from them are well conditioned. The points are generally so chosen that small angles will be avoided. In order to fulfill the other conditions, it frequently becomes necessary to carry forward the triangulation by means of stations located on points a considerable distance inland, such as mountain peaks, which would not otherwise be regarded as properly within the limits of the survey.

Great care should be taken in observing all angles upon which the main triangulation is based; the best available instrument should be employed; angles taken with a theodolite or transit should be repeated, and observed with telescope direct and reversed, and the mean result taken; if the sextant is used, a number of separate observations of each angle should be taken and averaged for the most probable value. It must be remembered that while, in any other part of the work, an error in an angle affects only the results in its immediate vicinity, a mistake in the main triangulation goes forward through all the plotting that comes after it.

It frequently occurs that the purposes of the survey are sufficiently well fulfilled by a graphic plotting of the main triangulation, but where more rigorous methods prevail, the results are obtained by calculation. The sum of the angles of each triangle is taken, and if it does not exactly equal 180° the values are adjusted to make them comply with this condition. The lengths of the various sides are then computed, regarding the stations, usually, as forming a series of quadrilaterals, and allowing for the curvature of the earth where the sides are sufficiently long to render it expedient to do so.

**449.** The Secondary Triangulation.—The points of the secondary triangulation are located, as far as possible, by angles from the main triangulation stations; these angles, having less dependent upon them, need not be repeated. A graphic plotting of these stations, without calculation, will suffice.

**450.** Astronomical Work.—This comprises the determination of the correct latitude and longitude of some point of the survey, which is the first position plotted, and of the true direction of some other point from the observation spot, which is the first line to be laid down on the chart; it is evident that these determinations form the origin of all positions and of all directions, without which the chart could not be constructed.

The methods of finding latitude, longitude, and the true bearing of a terrestrial object are fully set forth in previous chapters. The feature that distinguishes such work in surveying from that of determining the position of a ship at sea lies in the greater care that is taken to eliminate possible errors. At sea, results of absolute exactness are recognized as unattainable and are not required; but in a careful survey no step which will contribute to accuracy should be neglected.

The results should therefore be based upon a very large number of observations, employing the best instruments that are available, and the various sights being so taken that probable errors are offset in reckoning the mean.

**451.** By taking a number of sights the observer arrives at the most probable result of which his instruments and his own faculties render him capable; but this result is liable to an error whose amount is indeterminate and which is equal to the algebraic sum of a number of small errors due, respectively, to his instruments (which must always lack perfection in some details), to an improper allowance for refraction under existing atmospheric conditions, and to his own personal error. Assuming, as we may, that the personal error is approximately constant, these three causes give rise to an error by which all altitudes appear too great or too small by a uniform but unknown amount. Let us assume, for an illustration, that this error has the effect of making all altitudes appear 30″ too great; if an observer attempted to work his latitude from the meridian altitude of a star bearing south, the result of this unknown error would give a latitude 30″ south of the true latitude; if another star to the southward were observed, this mistake would be repeated; but if a star to the north were taken, the resulting latitude would be 30″ to the north. It is evident, therefore, that the true latitude will be the mean of the results of observation of the northern and the southern star, or the mean of the average of several northern stars and the average of several southern stars. A similar process of reasoning will show that errors in the determination of hour angle are offset by taking the mean of altitudes of objects respectively east and west of the meridian.

**452.** It must be remembered that the uniformity of the unknown error only exists where the altitude remains approximately the same, as instrumental and refraction errors may vary with the altitude; another condition of uniformity requires that the instrument and the observer remain the same, and that all observations be taken about the same time, in order that atmospheric conditions remain unchanged; to preserve uniformity, if the artificial horizon is used, the same end of the roof should always be the near one to the observer; in taking the sun, however, as the personal error may not be the same for approaching as for separating limbs, every series of observations should be made up of an equal number of sights taken under each condition.

**453.** With all of this in mind, we arrive at the general rule that astronomical determinations shall be based upon the mean of observations, under similar conditions, of bodies whose respective distances from the zenith are nearly equal, and which bear in opposite directions therefrom.

**454.** This condition eliminates the sun from availability for observations for latitude, though it properly admits the use of that body for longitude where equal altitudes or single a. m. and p. m. sights are taken. Opposite stars of approximately equal zenith distance should always be used for latitude, circum-meridian altitudes being observed during a few minutes before and after transit; excellent results are also obtained from stellar observations for longitude; but very low stars should be avoided, on account of the uncertainty of refraction, and likewise very high ones, as the reflection from the index mirror of the sextant may not be perfectly distinct when the ray strikes at an acute angle.

**455.** If there is telegraphic communication, an endeavor should be made to obtain a time signal from a reliable source, instead of depending upon the chronometers.

**456.** Topography.—The plane-table, with telemeter and stadia, affords the most expeditious means of plotting the topography, and should be employed when available. Points on shore may also be plotted by sextant angles, using the three-point problem, or by any other reliable method.

**457.** Hydrography.—The correct delineation of the hydrographic features being one of the most important objects of the survey, great care should be devoted to this part of the work. Soundings are run in one or more series of parallel lines, the direction and spacing of which depend upon the scope of the survey. It is usual for one series of lines to extend in a direction normal to the general trend of the shore line. In most cases a second series runs perpendicular to the first, and in surveys of important bodies of water still other series of lines cross the system diagonally. In developing rocks, shoals, or dangers the direction of the lines is so chosen as will best illustrate the features of the bottom. When lines cross, the agreement of the reduced soundings at their intersection affords a test of the accuracy of the work.

As the depth of water increases, if there is no reason to suspect dangers, the interval between lines may be increased.

Lines are run by the ship or boat in such manner as to follow as closely as possible the scheme of sounding that has been laid out. The position is located by angles at the beginning of each line, at each change of course, at frequent intervals along the line, and at the point where each line is finished. Soundings taken between *positions* are plotted by the time interval or patent-log distances.

**458.** There are a number of methods for determining positions while sounding, which may be described briefly as follows:

*By two sextant angles.*—Two observers with sextants measure simultaneously the angles between three objects of known position, and the position is located by the three-point problem. This is the method most commonly employed in boat work, and has the great advantage that the results may be plotted at once on the working sheet in the boat and the lines as run thus kept nearly in coincidence with those laid out in the scheme. A study of the three-point problem (art. 153, Chap. IV) will give the considerations that must govern in the selection of objects.

*By two theodolite angles.*—Two stations on shore are occupied by observers with theodolites, and at certain instants, indicated by a signal from the ship or boat, they observe the angular distance thereof from some known point. The intersection of the direction lines thus given is at the required position. This method is expeditious where the signals are small or not numerous. Its disadvantage is that the plotting can not be kept up as the work proceeds.

*By one sextant and one theodolite angle.*—An observer ashore occupies a station with a theodolite and cuts in the ship or boat, while one on board takes a sextant angle between two objects, of which one should preferably be the occupied station. It is plotted by laying off the direction line from the theodolite and finding with a three-armed protractor or piece of tracing paper what point of that line subtends the observed angle between the objects. Its advantages and disadvantages are the same as those of the preceding method.

In running lines of soundings offshore, where signals are lost sight of, the best method is to get an accurate departure, before dropping the land, by the best means that offers, keeping careful note of the the dead reckoning, and on running in again, to get a position as soon as possible, note the drift and reconcile the plotting of intermediate soundings accordingly. Where circumstances require, the position may be located by astronomical observations as usually taken at sea.

**459.** A careful record of soundings must be kept, showing the time of each (so that proper tidal correction may be applied), the depth, the character of bottom, and such data as may be required to locate the position.

**460.** Tidal Observations.—These should begin as early as practicable and continue throughout the survey, it being most important that they shall, if possible, cover the period of a lunar month. In the chapter on Tides (Chap. XX) the nature of the data to be obtained is explained.

**461.** Magnetic Observations.—The feature of the earth's magnetism with which the navigator is most concerned is the variation, which is set forth on the chart, and upon the determination of which will depend the correctness of all courses and bearings on shipboard. It is usually obtained by noting the compass direction from the observation spot of the object whose true bearing is known by calculation, and comparing the true and compass bearings; or it may be observed by mounting the ship's compass in a place on shore free from foreign magnetic influence, and finding the compass error as it is found on board. Observations for dip and intensity are also made when the proper instruments are at hand.

**462.** Running Survey.—Where time and opportunity permit only a superficial examination of a coast line or water area, or where the interests of navigation require no more, recourse is had to a *Running Survey*, in which shore positions are determined and soundings are made while the ship steams along the coast stopping only occasionally to fix her position, and in which the assistance of boat or shore parties may or may not be employed.

In this method the ship starts at one end of the field from a known position, fixed either by astronomical observations or by angles or bearings of terrestrial objects having a determined location. Careful compass bearings or sextant angles are taken from this position to all objects ashore which can be recognized, and a series of direction lines is thus obtained. The ship then steams along the coast, at a convenient distance therefrom, keeping accurate account of her run by compass courses and patent log.

From time to time other series of bearings or angles are taken upon those objects ashore which are to be located, the direction lines plotted from the estimated position of the ship, and the various objects located by the intersections with their other direction lines. During all the time that the ship is under way, soundings are taken at regular intervals and plotted from the dead reckoning. As frequently as circumstances permit, the ship is stopped and her position located by the best available means, and the intervening dead reckoning reconciled for any current that may be found.

If a steam launch can be employed in connection with a running survey, it is usually sent to run a second line inshore of the ship. The boat's position is obtained by bearings of objects ashore which are located by the ship, or by bearings and mast-head angles of the ship, or by such other means as offer. The duty of the boat is to take a series of soundings, and to collect data for shore line and topography.

If circumstances allow the landing of a shore party, its most important duty is to mark the various objects on shore by some sort of signals which will render them unmistakable. Beyond this, it can perform such of the duties assigned to shore parties in a regular survey as opportunity permits.

# CHAPTER XVIII.

## WINDS.

**463.** *Wind* is air in approximately horizontal motion. Observations of the wind should include its true direction, and its force or velocity. The direction of the wind is designated by the point of the compass from which it proceeds. The force of the wind is at sea ordinarily expressed in terms of the Beaufort Scale, each degree of this scale corresponding to a certain velocity in miles per hour, as explained in article 67, Chapter II.

**464.** The Cause of the Wind.—Winds are produced by differences of atmospheric pressure, which are themselves ultimately, and in the main, attributable to differences of temperature.

To understand how the air can be set in motion by these differences of pressure it is necessary to have a clear conception of the nature of the air itself.

The atmosphere which completely envelops the earth may be considered as a fluid sea at the bottom of which we live, and which extends upward to a considerable height, probably 200 miles, constantly diminishing in density as the altitude increases.

The air, or material of which this atmosphere is composed, is a transparent gas, which, like all other gases, is perfectly elastic and highly compressible. Although extremely light, it has a perfectly definite weight, a cubic foot of air at ordinary pressure and temperature weighing 1.22 ounces, or about one seven hundred and seventieth part of the weight of an equal volume of water. In consequence of this weight it exerts a certain pressure upon the surface of the earth, amounting on the average to 15 pounds for each square inch. To accurately measure this pressure, which is constantly undergoing slight changes, we ordinarily employ a mercurial barometer (art. 48, Chap. II), an instrument in which the weight of a column of air of given cross section is balanced against that of a column of mercury having an equal cross section; and instead of saying that the pressure of the atmosphere is a certain number of pounds on each square inch, we say that it is a certain number of inches of mercury, meaning thereby that it is equivalent to the pressure of a column of mercury that many inches in height, and one square inch in cross section.

All gases, air included, are highly sensitive to the action of heat, expanding or increasing in volume as the temperature rises, contracting or diminishing in volume as the temperature falls. Suppose now that the atmosphere over any considerable region of the earth's surface is maintained at a higher temperature than that of its surroundings. The warmed air will expand, and its upper layers will flow off to the surrounding regions, cooling as they go. The atmospheric pressure at sea level throughout the heated areas will thus be diminished, while that over the circumjacent cooler areas will be correspondingly increased. As the result of this difference of pressure, there will be movement of the surface air away from the region of high pressure and towards the region of low, somewhat similar to the flow of water which takes place through the connecting bottom sluice as soon as we attempt to fill one compartment of a divided vessel to a slightly higher level than that found in the other.

A difference of atmospheric pressure at sea level is thus immediately followed by a movement of the surface air, or by winds; and these differences of pressure have their origin in differences of temperature. If the atmosphere were everywhere of uniform temperature it would lie at rest on the earth's surface—sluggish, torpid and oppressive—and there would be no winds. This, however, is fortunately not the case. The temperature of the atmosphere is continually or periodically higher in one region than in another, and the chief variations in the distribution of temperature are systematically repeated year after year, giving rise to like systematic variations in the distribution of pressure.

**465.** The Normal Distribution of Pressure.—The winds, while thus due primarily to differences of temperature, stand in more direct relation to differences of pressure, and it is from this point of view that they are ordinarily studied.

In order to furnish a comprehensive view of the distribution of atmospheric pressure over the earth's surface, charts have been prepared showing the average reading of the barometer for any given period, whether a month, a season, or a year, and covering as far as possible the entire globe. These are known as isobaric charts, from the fact that all points at which the barometer has the same reading are joined by a continuous line or isobar.

The isobaric chart for the year (fig. 59) shows in each hemisphere a well-defined belt of high pressure (30.20 inches) completely encircling the globe, that in the northern hemisphere having its middle line about in latitude 35° North, that in the southern hemisphere about in latitude 30° South, these constituting the so-called meteorological tropics. From the summit or ridge of each of these belts the pressure falls off alike toward the equator and toward the pole, although much less rapidly in the former direction than in the latter. The equator itself is encircled by a belt of somewhat diminished pressure (29.90 inches), the middle line of which is ordinarily found in northern latitudes. In the northern hemisphere the diminution of pressure on the poleward slope is much less marked and much less regular than in the southern hemisphere, minima (29.70 inches) occurring in the North Atlantic Ocean near Iceland, and in the North Pacific Ocean near the Aleutian Islands, beyond which the pressure increases. In the southern hemisphere no such minima are apparent, the pressure continuing to diminish uninterruptedly as higher and higher latitudes are attained. Along the sixtieth parallel of south latitude the average barometric reading is 29.30 inches.
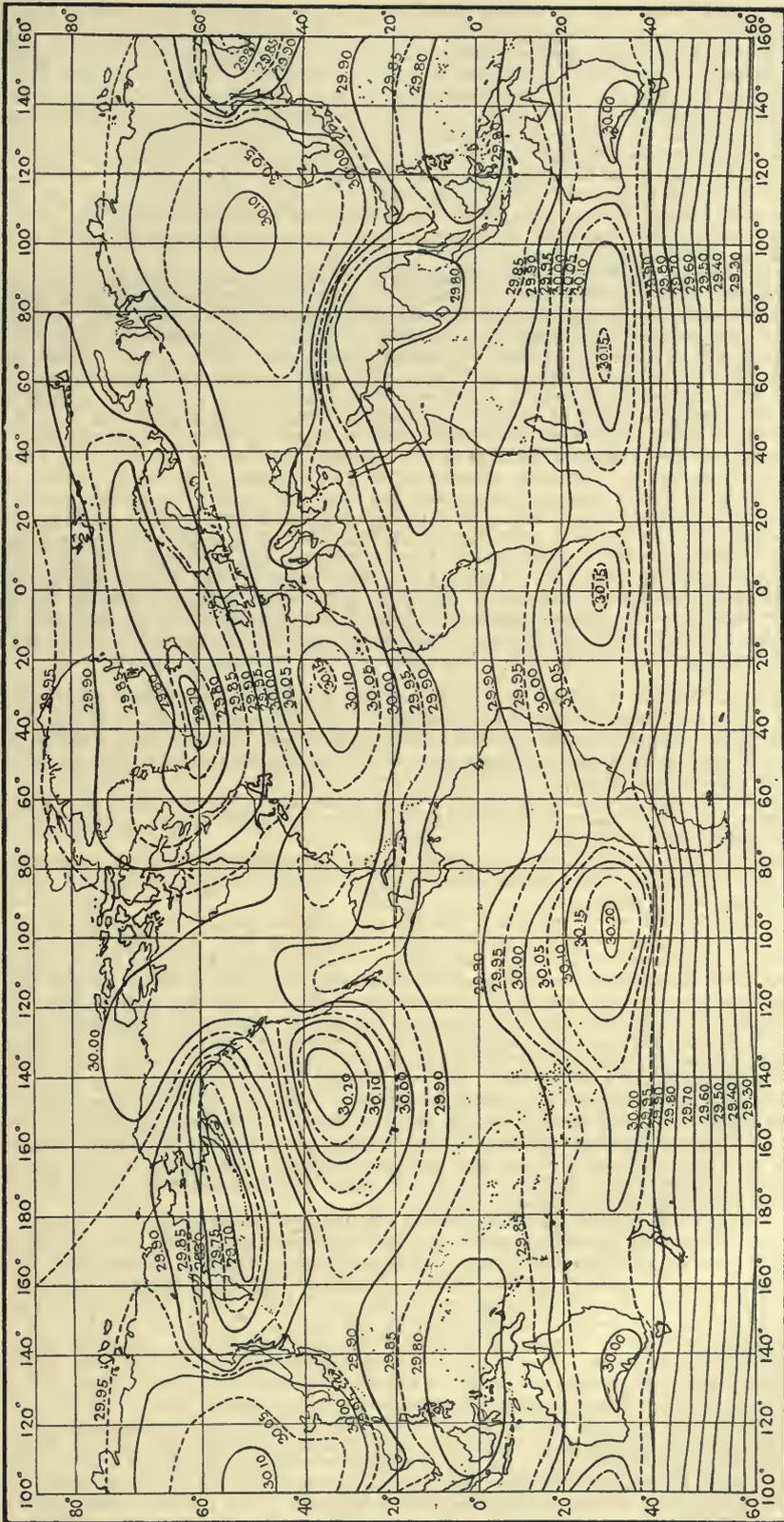
Fig. 59.

**466.** SEASONAL VARIATIONS OF PRESSURE.—As might be expected from its close relation to the temperature, the whole system of pressure distribution exhibits a tendency to follow the sun's motion in declination, the barometric equator occupying in July a position slightly to the northward of its position in January. In either hemisphere, moreover, the pressure over the land during the winter season is decidedly above the annual average, during the summer season decidedly below it; the extreme variations occurring in the case of continental Asia, where the mean monthly pressure ranges from 30.50 inches during January to 29.50 inches during July. Over the northern ocean, on the other hand, conditions are reversed, the summer pressures being here somewhat the higher. Thus, in January the Icelandic and the Aleutian minima increase in depth to 29.50 inches, while in July these minima fill up and are well-nigh obliterated, a fact which has much to do with the strength and frequency of the winter gales in high northern latitudes and the absence of these gales during the summer. Over the southern ocean, in keeping with its slight contrast between winter and summer temperatures, similar variations of pressure do not exist.

**467.** THE PREVAILING WINDS.—As a result of the distribution of pressure just described, there is in either hemisphere a continual motion of the surface air away from the meteorological tropic—on one side towards the equator, on the other side towards the pole, the first constituting in each case the trade winds, the second the prevailing winds of higher latitudes. Upon a stationary earth the direction of this motion would be immediately from the region of high towards the region of low barometer, the moving air steadily following the barometric slope or gradient, increasing in force to a gale where these gradients are steep, decreasing to a light breeze where they are gentle, sinking to a calm where they are absent. The earth, however, is in rapid rotation, and this rotation gives rise to a force which exercises a material influence over all horizontal motions upon its surface, whatever their direction, serving constantly to divert them to the *right* in the northern hemisphere, to the *left* in the southern. The air set in motion by the difference of pressure is thus constantly turned aside from its natural course down the barometric gradient or slope, and the direction of the wind at any point, instead of being identical with that of the gradient at that point, is deflected by a certain amount, crossing the latter at an angle which in practice varies between 45° and 90° (4 to 8 compass points), the wind in the latter case blowing parallel to the isobars. As a consequence of this deflection the northerly winds which one would naturally expect to find on the equatorial slope of the belt of high pressure in the northern hemisphere become northeasterly,—the NE. trade; the southerly winds of the polar slope become southwesterly,—the prevailing westerly winds of northern latitudes. So, too, for the southern hemisphere, the southerly winds of the equatorial slope here becoming southeasterly,—the SE. trades; the northerly winds of the polar slope northwesterly,—the prevailing westerly winds of southern latitudes.

**468.** The relation here described as existing between the distribution of atmospheric pressure and the direction of the wind is of the greatest importance. It may be briefly stated as follows:

In the northern hemisphere stand with the back to the wind; in this position the region of high barometer lies on your right hand and somewhat behind you; the region of low barometer on your left hand and somewhat in front of you.

In the southern hemisphere stand with the back to the wind; in this position the region of high barometer lies on your left hand and somewhat behind you; the region of low barometer on your right hand and somewhat in front of you.

This relation holds absolutely, not only in the case of the general distribution of pressure and circulation of the atmosphere, but also in the case of the special conditions of high and low pressure which usually accompany severe gales.

**469.** THE TRADE WINDS.—The *Trade Winds* blow from the tropical belts of high pressure towards the equatorial belt of low pressure—in the northern hemisphere from the northeast, in the southern hemisphere from the southeast. Over the eastern half of each of the great oceans they extend considerably farther from the line and their original direction inclines more towards the pole than in mid-ocean, where the latter is almost easterly. They are ordinarily looked upon as the most constant of winds, but while they may blow for days or even for weeks with slight variation in direction or strength, their uniformity should not be exaggerated. There are times when the trade winds weaken or shift. There are regions where their steady course is deformed, notably among the island groups of the South Pacific, where the trades during January and February are practically nonexistent. They attain their highest development in the South Atlantic and in the South Indian Ocean, and are everywhere fresher during the winter than during the summer season. They are rarely disturbed by cyclonic storms, the occurrence of the latter within the limits of the trade wind region being furthermore confined in point of time to the late summer and autumn months of the respective hemispheres, and in scene of action to the western portion of the several oceans. The South Atlantic Ocean alone, however, enjoys complete immunity from tropical cyclonic storms.

**470.** THE DOLDRUMS.—The equatorial girdle of low pressure occupies a position between the high-pressure belt of the northern and the similar belt of the southern hemisphere. Throughout the extent of this barometric trough the pressure, save for the slight diurnal oscillation, is practically uniform, and decided barometric gradients do not exist. Here, accordingly, the winds sink to stagnation, or rise at most only to the strength of fitful breezes, coming first from one point of the compass, then from another, with cloudy, rainy sky and frequent thunderstorms. The region throughout which these conditions prevail consists of a wedge-shaped area, the base of the wedge resting in the case of the Atlantic Ocean on the coast of Africa, and in the case of the Pacific Ocean on the coast of America, the axis extending westward. The position and extent of the belt vary somewhat with the season. Throughout February and March it is found immediately north of the equator and is of inappreciable width, vessels following the usual sailing routes frequently passing from trade to trade without interruption in both the Atlantic and the Pacific Oceans. In July and August it has migrated to the northward, the axis extending east and west along the parallel of 7° north, and the belt itself covering several degrees of latitude, even at its narrowest point. At this season of the year, also, the southeast trades blow with diminished freshness across the equator and well into the northern hemisphere, being here diverted, however, by the effect of the earth's rotation, into southerly and southwesterly winds, the so-called southwest monsoon of the African and Central American coasts.

**471.** THE HORSE LATITUDES.—On the outer margin of the trades, corresponding vaguely with the summit of the tropical ridge of high pressure in either hemisphere, is a second region throughout which the barometric gradients are faint and undecided, and the prevailing winds correspondingly light and variable, the so-called *horse latitudes*, or calms of Cancer and of Capricorn. Unlike the doldrums, however, the weather is here clear and fresh, and the periods of stagnation are intermittent rather than continuous, showing none of the persistency which is so characteristic of the equatorial region. The explanation of this difference will become obvious as soon as we come to study the nature of the daily barometric changes of pressure in the respective regions, these in the one case being marked by the uniformity of the torrid zone, in the other sharing to a limited extent in the wide and rapid variations of the temperate.

**472.** THE PREVAILING WESTERLY WINDS.—On the exterior or polar side of the tropical maxima the pressure again diminishes, the barometric gradients being now directed towards the pole; and the currents of air set in motion along these gradients, diverted to the right and left of their natural course by the earth's rotation, appear in the northern hemisphere as southwesterly winds, in the southern hemisphere as northwesterly—the prevailing westerly winds of the temperate zone.

Only in the southern hemisphere do these winds exhibit anything approaching the persistency of the trades, their course in the northern hemisphere being subject to frequent local interruption by periods of winds from the eastern semicircle. Thus the tabulated results show that throughout the portion of the North Atlantic included between the parallels 40°–50° North, and the meridians 10°–50° West, the winds from the western semicircle (South—NNW.) comprise about 74 per cent of the whole number of observations, the relative frequency being somewhat higher in winter, somewhat lower in summer. The average force, on the other hand, decreases from force 6 to force 4 Beaufort scale, with the change of season. Over the sea in the southern hemisphere such variations are not apparent; here the westerlies blow through the entire year with a steadiness little less than that of the trades themselves, and with a force which, though fitful, is very much greater, their boisterous nature giving the name of the "Roaring Forties" to the latitudes in which they are most frequently observed.

The explanation of this striking difference in the extra-tropical winds of the two halves of the globe is found in the distribution of atmospheric pressure, and in the variations which this latter undergoes in different parts of the world. In the landless southern hemisphere the atmospheric pressure after crossing the parallel of 30° South diminishes almost uniformly towards the pole, and is rarely disturbed by those large and irregular fluctuations which form so important a factor in the daily weather of the northern hemisphere. Here, accordingly, a system of polar gradients exists quite comparable in stability with the equatorial gradients which give rise to the trades; and the poleward movement of the air in obedience to these gradients, constantly diverted to the left by the effect of the earth's rotation, constitutes the steady westerly winds of the south temperate zone.

**473.** THE MONSOON WINDS.—The air over the land is warmer in summer and colder in winter than that over the adjacent oceans. During the former season the continents thus become the seat of areas of relatively low pressure; during the latter of relatively high. Pressure gradients, directed outward during the winter, inward during the summer, are thus established between the land and the sea, which exercise the greatest influence over the winds prevailing in the region adjacent to the coast. Thus, off the Atlantic seaboard of the United States southwesterly winds are most frequent in summer, northwesterly winds in winter; while on the Pacific coast the reverse is true, the wind here changing from northwest to southwest with the advance of the colder season.

The most striking illustration of winds of this class is presented by the *monsoons* (*Mausum*, season) of the China Sea and of the Indian Ocean. In January abnormally low temperatures and high pressure obtain over the Asiatic plateau, high temperatures and low pressure over Australia and the nearby portion of the Indian Ocean. As a result of the baric gradients thus established, the southern and eastern coast of the vast Asiatic continent and the seas adjacent thereto are swept by an outflowing current of air, which, diverted to the right of the gradient by the earth's rotation, appears as a northeast wind, covering the China Sea and the northern Indian Ocean. Upon entering the southern hemisphere, however, the same force which hitherto deflected the moving air to the right of the gradient now serves to deflect it to the left; and here, accordingly, we have the monsoon appearing as a northwest wind, covering the Indian Ocean as far south as 10°, the Arafura Sea, and the northern coast of Australia.

In July these conditions are precisely reversed. Asia is now the seat of high temperature and correspondingly low pressure, Australia of low temperature and high pressure, although the departure from the annual average is by no means so pronounced in the case of the latter as in that of the former. The baric gradients thus lead across the equator and are addressed toward the interior of the greater continent, giving rise to a system of winds whose direction is southeast in the southern hemisphere, southwest in the northern.

The northeast (winter) monsoon blows in the China Sea from October to April, the southwest (summer) monsoon from May to September. The former is marked by all the steadiness of the trades, often attaining the force of a moderate gale; the latter appears as a light breeze, unsteady in direction, and often sinking to a calm. Its prevalence is frequently interrupted by tropical cyclonic storms, locally known as *typhoons*, although the occurrence of these latter may extend well into the season of the winter monsoon.

**474.** LAND AND SEA BREEZES.—Corresponding with the seasonal contrast of temperature and pressure over land and water, there is likewise a diurnal contrast which exercises a similar though more local effect. In summer particularly, the land over its whole area is warmer than the sea by day, colder than the sea by night, the variations of pressure thus established, although insignificant, sufficing to evoke a system of littoral breezes directed landward during the daytime, seaward during the night, which, in general, do not penetrate to a distance greater than 30 miles on and off shore, and extend but a few hundred feet into the depths of the atmosphere.

The sea breeze begins in the morning hours—from 9 to 11 o'clock—as the land warms. In the late afternoon it dies away. In the evening the land breeze springs up, and blows gently out to sea until

morning.   In the tropics this process is repeated day after day with great regularity.   In our own latitudes, the land and sea breezes are often masked by winds of cyclonic origin.

**475.** A single important effect of the seasonal variation of temperature and pressure over the land remains to be described.   If there were no land areas to break the even water surface of the globe, the trades and westerlies of the terrestrial circulation would be developed in the fullest simplicity, with linear divisions along latitude circles between the several members—a condition nearly approached in the land-barren southern hemisphere during the entire year, and in the northern hemisphere during the winter season.   In the summer season, however, the tropical belt of high pressure is broken where it crosses the warm land, and the air shouldered off from the continents accumulates over the adjacent oceans, particularly in the northern or land hemisphere.   This tends to create over each of the oceans a circular or elliptical area of high pressure, from the center of which the baric gradients radiate in all directions, giving rise to an outflowing system of winds, which by the effect of the earth's rotation is converted into an outflowing spiral eddy or *anticyclonic whirl*.   The sharp lines of demarcation which would otherwise exist between the several members of the general circulation are thus obliterated, the southwesterly winds of the middle northern latitudes becoming successively northwesterly, northerly, and northeasterly, as we approach the equator and round the area of high pressure by the east; the northeast trade becoming successively southeasterly, southerly, and southwesterly, as we recede from the equator and round this area by the west; similarly for the other hemisphere.

# CHAPTER XIX.

## CYCLONIC STORMS.

**476.** VARIATIONS OF THE ATMOSPHERIC PRESSURE.—The distribution of the atmospheric pressure previously described (Chap. XVIII) and the attendant circulation of the winds are those which become evident after the effects of many disturbing causes have been eliminated by the process of averaging, or embracing in the summation observations covering an extended period of time. The distribution of pressure and the system of winds which actually exist at a given instant will in general agree with these in its main features, but may differ from them materially in detail.

Confining our attention for the time being to the subject of atmospheric pressure, it may be said that this, at any given point on the earth's surface, is in a constant state of change, the mercury rarely becoming stationary, and then only for a few hours in succession. The variations which the pressure undergoes may be divided into two classes; viz, periodic, or those which are continuously in operation, repeating themselves within fixed intervals of time, long or short; and non-periodic or accidental, which occur irregularly, and are of varying duration and extent.

**477.** PERIODIC VARIATIONS.—Of the former class of changes the most important are the seasonal, which have been already to some extent described, and the diurnal. The latter consists of the daily occurrence of two barometric maxima, or points of highest pressure, with two intervening minima. Under ordinary circumstances, with the atmosphere free from disturbances, the barometer each day attains its first minimum about 4 a. m. As the day advances the pressure increases, and a maximum, or point of greatest pressure, is reached about 10 a. m. From this time the pressure diminishes, and a second minimum is reached about 4 p. m., after which the mercury again rises, reaching its second maximum about 10 p. m. The range of this diurnal oscillation is greatest at the equator, where it amounts to ten hundredths (0.10) of an inch. It diminishes with increased latitude, and near the poles it seems to vanish entirely. In middle latitudes it is much more apparent in summer than in winter.

**478.** NON-PERIODIC VARIATIONS.—The equatorial slope of the tropical belt of high pressure which encircles the globe in either hemisphere is characterized by the marked uniformity of its meteorological conditions, the temperature, wind, and weather changes proper to any given season repeating themselves as day succeeds day with almost monotonous regularity. Here the diurnal oscillation of the barometer constitutes the main variation to which the atmospheric pressure is subjected. On the polar slope of these belts conditions the reverse of these obtain, the elements which go to make up the daily weather here passing from phase to phase without regularity, with the result that no two days are precisely alike; and as regards atmospheric pressure, it may be said that in marked contrast with the uniformity of the torrid zone, the barometer in the temperate zone is constantly subjected to non-periodic or accidental fluctuations of such extent that the periodic diurnal variation is scarcely apparent, the mercury at a given station frequently rising or falling several tenths of an inch in twenty-four hours.

**479.** PROGRESSIVE AREAS OF HIGH AND LOW PRESSURE.—The explanation of this rapid change of conditions is found in the approach and passage of extensive areas of alternately high and low pressure, which affect alike, although to a different degree, all the barometers coming within their scope. The general direction of motion of these areas is that of the prevailing winds; eastward, therefore, in the latitudes which are under consideration.

Taken in conjunction, these areas of high and low pressure exercise a controlling influence over the weather changes of the temperate zones. As the low area draws near, the sky becomes overclouded, the prevailing westerly wind falls away, and is succeeded by a wind from some easterly direction, faint at first, but increasing as the pressure continues to diminish; the lowest pressure having been reached, the wind again goes to the westward, the glass starts to rise, and the weather clears; all marking the eastward recession of the low area and the approach of the subsequent high.

The first stage in the development of the low is a slight diminution of the atmospheric pressure, amounting in general to not more than one or two hundredths of an inch, throughout an area covering a more or less extensive portion of the earth's surface, either land or water, but far more frequently over the former than over the latter. Shortly after the advent of this initiatory fall the decrease of pressure throughout some small region within the larger area assumes a more decided character, the mercury here standing at a lower level than elsewhere and reading successively higher as we go outward, the region thus becoming, as it were, the center of the whole barometric depression. A system of barometric gradients is by this means established, all directed radially inward, and in obedience to these gradients there is a movement of the surface air towards the center or point of lowest barometer. The air once in motion, however, the effect of the earth's rotation is brought into play precisely as in the case of the larger movements of the atmosphere, with the result that the several currents, instead of following the natural course along these gradients, are deflected from them, in the northern hemisphere to the right hand, in the southern hemisphere to the left, the extent of the deflection being from 4 to 8 compass points.

**480.** CYCLONES AND CYCLONIC CIRCULATIONS.—A central area of low barometer will thus be surrounded by a system of winds which constantly draw in towards the center but at the same time circulate about it, the whole forming an inflowing spiral; the direction of this circulation being in the southern hemisphere with the motion of the hands of a watch, in the northern hemisphere opposed to this

motion. Where the barometric gradients are steep, these winds are apt to be strong; where they are gentle, the winds are apt to be weak; where they are absent, as is the case at the center or bottom of the depression, calms are apt to prevail.

Around the center of the area of high pressure a similar system of wind will be found, but blowing in a contrary direction. Here the barometric gradients are directed radially outward, with the result that in place of the inflowing, we have an outflowing spiral, the circulatory motion being right handed or with the hands of a watch in the northern hemisphere, left handed or against the hands of a watch in the southern.

All of these features are shown in the accompanying diagrams (fig. 60), which exhibit the general character of cyclonic (around the low) and anticyclonic (around the high) circulations in the northern
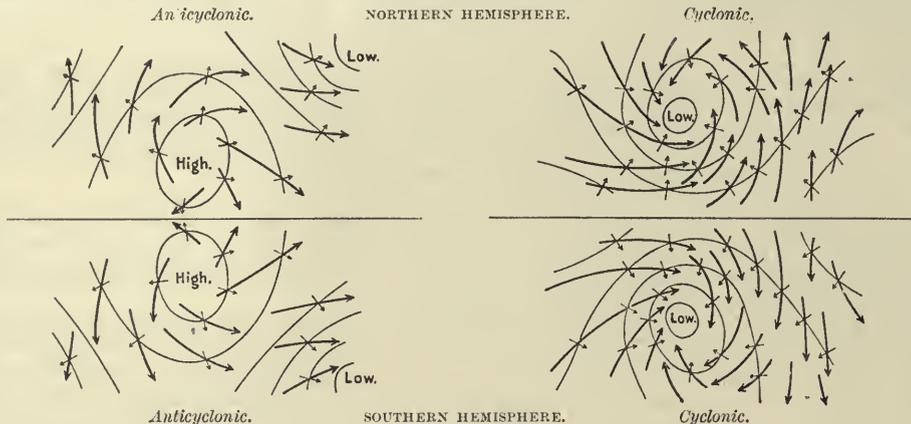


FIG. 60.

The light arrows show the direction of the gradients; the heavy arrows the direction of the winds.

and the southern hemisphere, respectively. The closed curves represent the isobars, or lines along which the barometric pressure is the same; the short arrows show the direction of the gradients, which are everywhere at right angles to the isobars; the long arrows give the direction of the winds, deflected by the earth's rotation to the right of the gradients in the northern hemisphere, to the left in the southern.

**481.** FEATURES OF CYCLONIC AND ANTICYCLONIC REGIONS.—Certain features of the two areas may here be contrasted. In the anticyclonic, the successive isobars are as a rule far apart, showing weak gradients and consequently light winds; the areas themselves are of relatively great extent, and their rate of progression is slow. During the summer they originate as extensions into higher latitudes of the margins of the tropical belts of high pressure; during the winter, as offshoots of the strong anticyclone which covers the land throughout that season. Their approach and presence is accompanied by polar or westerly winds, temperature below the seasonal average, fair weather, and clear skies. In the cyclonic area the successive isobars are crowded together, showing steep gradients and strong winds; they may appear either as trough-like extensions into the temperate zone of the polar belt of low pressure, in which case the easterly winds proper to their polar side are nonexistent, or (in lower latitudes) as independent areas, sometimes, indeed, as detached portions of the equatorial low-pressure belt, which move eastward and poleward across the temperate zone, and are ultimately merged into the great cyclonic area surrounding the pole. The progress of these independent areas is invariably attended by the strong and steadily shifting winds, foul weather, and other features which make up the ordinary storm at sea. In the trough-like depressions of higher latitudes these features may or may not be observed, their presence depending upon the depths of the barometric trough and the steepness of its slopes. In these, moreover, the cyclonic circulation is never completely developed, the storm winds having rather the character of right line gales, blowing from an equatorial or easterly direction until the axis of the trough is at hand, and as this passes shifting by the west at one bound to a polar direction.

**482.** CYCLONIC STORMS.—Strong winds are the result of steep barometric gradients. These may occur with cyclonic or with anticyclonic areas, the latter being exemplified in the case of the northers in the Gulf of Mexico and the northwesterly winter gales along the Atlantic coast of the United States, which are almost invariably accompanied by barometers above the average. They are, however, so much more frequent in the case of areas of low pressure and consequent cyclonic circulations, with their attendant foul weather characteristics, that the latter are generally known as cyclonic storms, i. e., storms in which the wind circulation is cyclonic.

Cyclonic storms may with convenience be divided into two classes; viz, tropical, or those which originate near but not on the equator; and extra-tropical, or those which first appear in higher latitudes.

**483.** TROPICAL CYCLONIC STORMS.—The occurrence of tropical cyclonic storms is confined to the summer and autumn months of the respective hemispheres, and to the western part of the several oceans, the North Atlantic, the North Pacific, the South Pacific, and the Indian Ocean. They are unknown in the South Atlantic Ocean.

The Arabian Sea and the Bay of Bengal are also visited by cyclonic storms, the season of their occurrence extending from May to October.

**484.** MOTION OF THE STORM CENTER.—In the case of tropical cyclonic storms there is always a tendency for the barometric depression, impelled by the general motion of the atmosphere in the

trade wind region, to follow a path which tends at once westward and away from the equator. This motion continues until the limits of the trades are reached, where the path ordinarily recurves, and the subsequent motion of the depression is eastward and towards the pole, the disturbance at the same time assuming the features of the extra-tropical cyclonic storm.

**485.** RATE OF PROGRESS OF THE STORM CENTER.—Within the tropics (in the northern hemisphere) the average velocity of the storm center along the track is about 17 miles per hour; in the latitudes of recurvature this drops to 8 miles per hour, the center at the time frequently becoming stationary; in higher latitudes it again increases, rising to 20 or even to 30 miles per hour.

In the southern hemisphere the average velocity of progress as far as determined is somewhat less than in the northern, but shows about the same relation in different parts of the track.

The general path of the tropical cyclonic storm in either hemisphere and the cyclonic circulation of the wind about the storm center are given in figures 61 and 62; that for the northern hemisphere applying to the West India hurricane; that for the southern hemisphere to the hurricanes of the South Pacific Ocean.

**486.** CHARACTER OF TROPICAL CYCLONIC STORMS.—Within the tropics the storm area is small, the region covered by violent winds extending in general not more than 150 miles from the center. The barometric gradients are, however, exceedingly steep, instances having been recorded in which the difference of pressure for this distance amounted to 2 inches. In the typhoons of the North Pacific Ocean gradients of one inch in 60 miles are not infrequent. The successive isobars are almost circular. As a consequence of this distribution of pressure the winds on the slopes of the depression are frequently of great violence, and in the matter of direction they are more symmetrically disposed about the center than is the case with the larger and less regularly shaped depressions of higher latitudes. In these low latitudes the average values of the deflection of the wind from the barometric gradient is in the neighborhood of six compass points,—to the right in the northern hemisphere, to the left in the southern.

**487.** To FIX THE BEARING OF THE STORM CENTER FROM THE VESSEL.—On this assumption, the following rules will enable an observer to fix the bearing of the storm center from his vessel:—

In the northern hemisphere, stand with the back to the wind; the storm center will bear six points to the observer's left.

In the southern hemisphere, stand with the back to the wind; the storm center will bear six points to the observer's right.

On the basis of these rules the tables hereafter given (art. 492) show the bearing of the center corresponding to a wind of any direction.



FIG. 61.

**488.** To FIX THE DISTANCE OF THE STORM CENTER FROM THE VESSEL.—The following table, taken from Piddington's "Sailor's Horn Book," may prove of some assistance in estimating the distance of the storm center from the vessel:

| Average fall of the barometer per hour. | Distance from the storm center. |
| --- | --- |
| From 0.02 to 0.06 in. | From 250 to 150 miles. |
| From 0.06 to 0.08 in. | From 150 to 100 miles. |
| From 0.08 to 0.12 in. | From 100 to 80 miles. |
| From 0.12 to 0.15 in. | From 80 to 50 miles. |

The table assumes that the vessel is hove-to in front of the storm, and that the latter is advancing directly toward it.

**489.** To AVOID THE CENTER OF THE STORM.—In the immediate neighborhood of the center itself the winds attain full hurricane force, the sea is exceedingly turbulent, and there is danger of being struck aback. Every effort should therefore be made to avoid this region, either by running or by heaving-to; and if recourse is had to the latter maneuver, much depends upon the selection of the proper tack; this being in every case the tack which will cause the wind to draw aft with each successive shift.

A vessel hove-to in advance of a tropical cyclonic storm will experience a long heavy swell, a falling barometer with torrents of rain, and winds of steadily increasing force. The shifts of wind will depend upon the position of the vessel with respect to the path followed by the storm center. Immediately upon the path, the wind will hold steady in direction until the passage of the central calm, the "eye of the storm," after which the gale will renew itself, but from a direction opposite to that which it previ-

ously had. To the right of the path, or in the right-hand semicircle of the storm (the observer being supposed to face along the track), the wind, as the center advances and passes the vessel, will constantly shift to the right, the rate at which the successive shifts follow each other increasing with the proximity to the center; in this semicircle, then, in order that the wind shall draw aft with each shift, the vessel must be hove-to on the starboard tack; similarly, in the left-hand semicircle, the wind will constantly shift to the left, and here the vessel must be hove-to on the port tack.
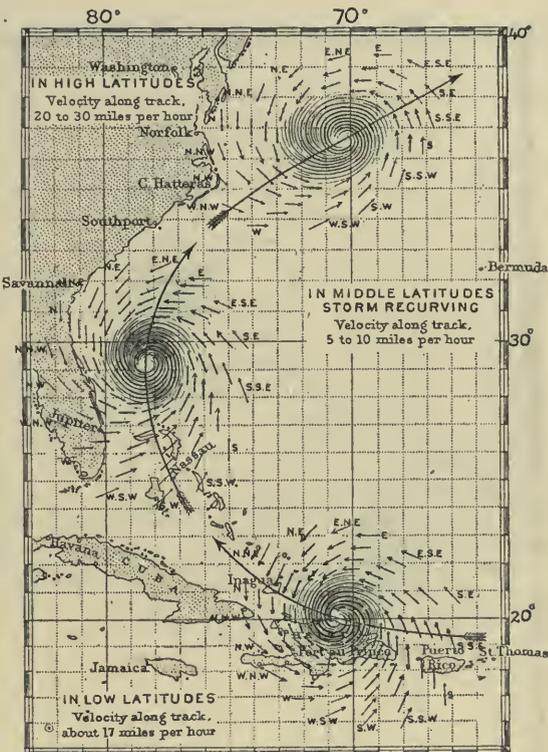
These rules hold alike for both hemispheres and for cyclonic storms in all latitudes.

The above shifts of the wind are based upon the supposition that the vessel is lying-to. A vessel in rapid westerly motion may, in low latitudes, readily overtake the storm center, in which case the observed shifts will be just the reverse of those here described.

**490. DANGEROUS AND NAVIGABLE SEMICIRCLES.**—Prior to recurving, the winds in that semicircle of the storm which is more remote from the equator (the right-hand semicircle in the northern hemisphere, the left-hand semicircle in the southern) are liable to be more severe than those of the opposite semicircle. A vessel hove-to in the semicircle adjacent to the equator has also the advantage of immunity from becoming involved in the actual center itself, inasmuch as there is a distinct tendency on the part of the latter to move away from the equator. For these reasons the more remote semicircle has been called the *dangerous;* the less remote, the *navigable.*

**491. MANEUVERING.**—A vessel suspecting the dangerous proximity of a tropical cyclonic storm should lie-to for a time on the starboard tack to locate the center by observing shifts of the wind and the behavior of the barometer. If the former holds steady and increases in force, while the latter falls rapidly, say at a greater rate than 0.03 of an inch per hour, the vessel is probably on the track of the storm and in advance of the center. In this position the proper step (providing, of course, that sea room permits) is to run, keeping the wind, in the northern hemisphere, at all times well on the starboard quarter; in the southern hemisphere, well on the port; and thus constantly increasing the distance to the storm center. The same rule holds good if the observation places the vessel at but a scant distance within the forward quadrant of the dangerous semicircle. Here, too, the natural course will be to seek the navigable semicircle of the storm, even though such a course involves crossing the track in advance of the center, always exercising due caution to keep the wind from drawing too far aft.

The critical case is that of a vessel which finds herself in the forward quadrant of the dangerous semicircle and at a considerable distance from the track, for here the shifts of the wind are sluggish and the indications of the barometer are undecided, both causes conspiring to render the bearing of the center doubtful. If, upon heaving-to, the barometer becomes stationary, the position should be maintained until indications of a rise are apparent, upon which the course may be resumed with safety and held as long as the rise continues. If, however, the barometer falls, a steamer should make a run to the NNE. or NE. (southern hemisphere, SSE. or SE.), keeping the wind and sea a little on the port (southern hemisphere, starboard) bow, and using such speed as will at least keep the mercury stationary. Such a step will in general be attended with the assurance that the present weather conditions will in any case grow no worse. For a sailing vessel, unable to stand closer to the wind than six points, the last maneuver will be impossible, and driven to leeward by wind, sea, and current, she may be compelled to cross the track immediately in advance of the center, or may even become involved in the center itself. In this extremity the path of the storm center during the past twenty-four hours should be laid down on a diagram as accurately as the observations permit, and the line prolonged for some distance beyond the present position of the center. Having assumed an average rate of progress for the center, its probable position on the line should be frequently and carefully plotted, and the handling of the vessel should be in accordance with the diagram.

**492. SUMMARY OF RULES.**—The following summary comprises the rules for maneuvering in the *Northern Hemisphere,* so far as they may be made general:—
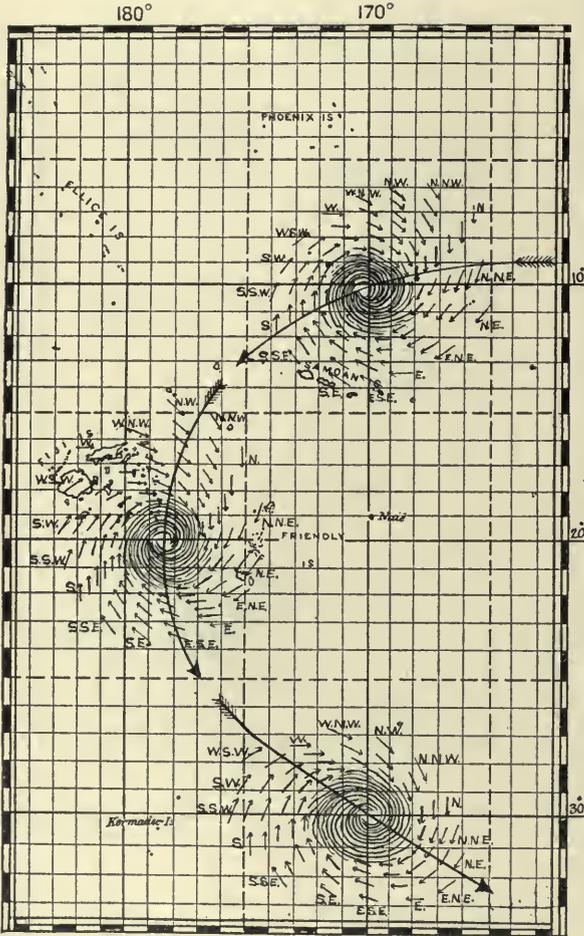


FIG. 62.

*In the Right Semicircle:* Haul by the wind on the starboard tack and carry sail as long as possible; if obliged to heave-to, do so on starboard tack.

*In the Left Semicircle:* Bring the wind on the starboard quarter, note course and keep it; if obliged to heave-to, do so on port tack.

*In Front of Center:* Bring wind two points on starboard quarter, note course and keep it; if obliged to heave-to, do so on port tack.

*In Rear of Center:* Run out with wind on starboard quarter; if obliged to heave-to, do so on starboard tack.

The application of these rules for the various directions of the wind is shown in the following table:—

*Storm Table, Northern Hemisphere.*

| Direction of wind. | Direction of center. | If wind shifts towards the right. | If wind shifts towards the left. | If wind steady with falling barometer. | If wind steady with rising barometer. |
|---|---|---|---|---|---|
| North. | ESE. | | Run SSW. | Run SSW. | Run SSW. |
| NNE. | SE. | | Run SW. | Run SW. | Run SW. |
| NE. | SSE. | | Run WSW. | Run WSW. | Run WSW. |
| ENE. | South. | | Run West. | Run West. | Run West. |
| East. | SSW. | | Run WNW. | Run WNW. | Run WNW. |
| ESE. | SW. | | Run NW. | Run NW. | Run NW. |
| SE. | WSW. | | Run NNW. | Run NNW. | Run NNW. |
| SSE. | West. | | Run North. | Run North. | Run North. |
| South. | WNW. | | Run NNE. | Run NNE. | Run NNE. |
| SSW. | NW. | | Run NE. | Run NE. | Run NE. |
| SW. | NNW. | | Run ENE. | Run ENE. | Run ENE. |
| WSW. | North. | | Run East. | Run East. | Run East. |
| West. | NNE. | | Run ESE. | Run ESE. | Run ESE. |
| WNW. | NE. | | Run SE. | Run SE. | Run SE. |
| NW. | ENE. | | Run SSE. | Run SSE. | Run SSE. |
| NNW. | East. | | Run South. | Run South. | Run South. |

*If wind shifts towards the right:* Haul by wind on starboard tack and carry sail as long as possible; if obliged to heave-to, do so on starboard tack.

*If wind shifts towards the left:* Hold course a as long as possible; if obliged to heave-to, do so on port tack.

*If wind steady with falling barometer:* Hold course as long as possible; if obliged to heave-to, do so on port tack.

*If wind steady with rising barometer:* Hold course a as long as possible; if obliged to heave-to, do so on starboard tack.

a Courses given are for wind two points on starboard quarter, but it is preferable to take wind broad on quarter if possible.

Similarly, the following rules and table apply for the *Southern Hemisphere:*—

*In the Right Semicircle:* Bring the wind on the port quarter, note course and keep it; if obliged to heave-to, do so on starboard tack.

*In the Left Semicircle:* Haul by the wind on the port tack and carry sail as long as possible; if obliged to heave-to, do so on port tack.

*In Front of Center:* Bring wind two points on port quarter, note course and keep it; if obliged to heave-to, do so on starboard tack.

*In Rear of Center:* Run out with wind on port quarter; if obliged to heave-to, do so on port tack.

*Storm Table, Southern Hemisphere.*

| Direction of wind. | Direction of center. | If wind shifts towards the right. | If wind shifts towards the left. | If wind steady with falling barometer. | If wind steady with rising barometer. |
|---|---|---|---|---|---|
| North. | WSW. | Run SSE. | | Run SSE. | Run SSE. |
| NNE. | West. | Run South. | | Run South. | Run South. |
| NE. | WNW. | Run SSW. | | Run SSW. | Run SSW. |
| ENE. | NW. | Run SW. | | Run SW. | Run SW. |
| East. | NNW. | Run WSW. | | Run WSW. | Run WSW. |
| ESE. | North. | Run West. | | Run West. | Run West. |
| SE. | NNE. | Run WNW. | | Run WNW. | Run WNW. |
| SSE. | NE. | Run NW. | | Run NW. | Run NW. |
| South. | ENE. | Run NNW. | | Run NNW. | Run NNW. |
| SSW. | East. | Run North. | | Run North. | Run North. |
| SW. | ESE. | Run NNE. | | Run NNE. | Run NNE. |
| WSW. | SE. | Run NE. | | Run NE. | Run NE. |
| West. | SSE. | Run ENE. | | Run ENE. | Run ENE. |
| WNW. | South. | Run East. | | Run East. | Run East. |
| NW. | SSW. | Run ESE. | | Run ESE. | Run ESE. |
| NNW. | SW. | Run SE. | | Run SE. | Run SE. |

*If wind shifts towards the right:* Hold course a as long as possible; if obliged to heave-to, do so on starboard tack.

*If wind shifts towards the left:* Haul by wind on port tack and carry sail as long as possible; if obliged to heave-to, do so on port tack.

*If wind steady with falling barometer:* Hold course as long as possible; if obliged to heave-to, do so on starboard tack.

*If wind steady with rising barometer:* Hold course a as long as possible; if obliged to heave-to, do so on port tack.

a Courses given are for wind two points on port quarter, but it is preferable to take wind broad on quarter, if possible.

**493. Extra-Tropical Cyclonic Storms.**—On turning to the cyclones of temperate latitudes, we find many features in which they resemble those of the torrid zone, but certain other features in which they differ. Their fundamental resemblance to tropical cyclones is seen in their incurving winds, forming an inflowing left-handed spiral about the center of low pressure in the northern hemisphere, an inflowing right-handed spiral in the southern. The intensity of these winds varies with the depth of the barometric depression. The depression itself, however, in place of covering a few miles, as is the case in the tropics, will frequently have a diameter of several hundred or even a thousand miles, and for some distance around the center the gradients will have a tolerably strong value. For this reason there is less concentration of violence close to the center, and the calm and clear central space, or "eye," is seldom sharply developed, although it is not uncommon to discover a gradual weakening or failing of the winds, and sometimes even an imperfect breaking away of the clouds as the central area passes over the observer. The form of tropical cyclones as defined by their isobaric lines is nearly circular. Extra-tropical cyclones are as a rule less symmetrical, and their isobars are often elongated into an oval form, the longer axis of the oval trending (in the northern hemisphere) between north and east—about, therefore, in the direction of progression. The steepest gradients, and consequently the strongest winds, are apt to be found on the equatorial and westerly sides of the depression.

Extra-tropical cyclones generally follow an easterly course, inclining somewhat towards the pole; but they occasionally turn to one side or the other, become stationary, or even move backward. The velocity of progression varies from 15 to 40 miles an hour. If they exist as independent barometric depressions, with strong upward gradients on all sides of the center, the cyclonic circulation will be complete, the wind shifting with the sun for an observer situated in the equatorial semicircle of the storm, against the sun for an observer situated in the polar semicircle.

**494. Storms Along the Transatlantic Steamship Routes.**—The storms which are so frequently met during the winter season along the steamship routes between America and Europe are not, as a rule, due to central barometric depressions, but to depressions having a trough or V shape, which extend southerly from the extensive permanent area of low pressure having its center in the vicinity of Iceland. They are not attended by complete cyclonic circulations, inasmuch as the polar gradients which would otherwise give rise to easterly winds on this polar side are lacking. Their approach is heralded by a gradual hauling of the wind to southward, which is later followed (at the time of passage of the central line of the trough) by a change to NW., accompanied by heavy rain squalls and a rapid increase in force. The general distribution of pressure and the surrounding winds are shown in figure 63.
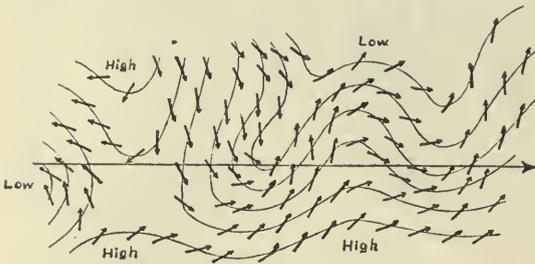


Fig. 63.

The changes in wind and pressure ensue much more rapidly in the case of a westward-bound vessel than in that of one eastward bound, the rate at which the observer and the depression approach each other being in the former case the sum of his own westward velocity and the eastward velocity of the trough, in the latter case, the difference of these velocities.

# CHAPTER XX.

## TIDES.

**495.** DEFINITIONS.—Tidal phenomena present themselves to the observer under two aspects—as alternate elevations and depressions of the sea, and as recurrent inflows and outflows of streams. The word *tide*, in common and general usage, is made to refer without distinction to both the vertical and horizontal motions of the sea, and confusion has sometimes arisen from this double application of the term; in its strict sense, this word may be used only with reference to the changes of elevation, while the recurrent streams are properly distinguished as *tidal currents*.

The tide rises until it reaches a maximum height called *high water* or *high tide*, and then falls to a minimum level called *low water* or *low tide;* that period at high or low water marking the transition between the tides, during which no vertical change can be detected, is called *stand*.

Of the tidal currents, that which arises from a movement of the water in a direction, generally speaking, from the sea toward the land, is called *flood*, and that arising from an opposite movement, *ebb;* the intermediate period between the currents, during which there is no horizontal motion, is distinguished as *slack*. *Set* and *drift* are terms applicable to the tidal currents, the first referring to the direction and the second to the velocity.

Care should be taken to avoid confusing the terms relating to tides with those which relate to tidal currents.

**496.** CAUSE.—The cause of the tides is the unequal attraction of the sun and moon upon different parts of the earth. These bodies attract the parts of the earth's surface which are nearer to them with greater force than they do its center, and attract its center more than they do its opposite surface; to restore equilibrium the waters take a spheroidal figure, whose longer axis lies in the direction of the attracting body. The mean force of the moon in raising the tides is two and a half times as great as that of the sun, for though the mass of the sun is vastly greater than the mass of the moon, the sun's distance is so great that it attracts the different parts of the earth with nearly equal force. Theory is not sufficiently advanced to render possible a prediction of tides or tidal changes from a mere knowledge of the positions of the sun and moon, but by theory, supplemented by observation of actual tidal conditions during a certain period of time, very accurate predictions may be arrived at.

**497.** ESTABLISHMENT.—High and low water occur, on the average of the twenty-eight days comprising a lunar month, at about the same intervals after the transit of the moon over the meridian. These nearly constant intervals, expressed in hours and minutes, are known respectively as the *high water lunitidal interval* and *low water lunitidal interval*.

The interval between the moon's meridian passage at any place and the time of the next succeeding high water, as observed on the days when the moon is at full or change, is called the *vulgar* (or *common*) *establishment* of that place, or, sometimes, simply the *establishment*. This interval is frequently spoken of as the *time of high water on full and change days* (abbreviated "H. W. F. & C."); for since, on such days, the moon's two transits (upper and lower) over the meridian occur about noon and midnight, the vulgar establishment then corresponds closely with the local times of high water. When more extended observations have been made, the average of all the high water lunitidal intervals for at least a lunar month is taken to obtain what is termed, in distinction to the vulgar establishment, the *corrected establishment* of the port, or *mean high water lunitidal interval*. In defining the tidal characteristics of a place some authorities give the corrected establishment, and others the vulgar establishment, or "high water, full and change;" calculations based upon the former will more accurately represent average conditions, though the two intervals seldom differ by a large amount.

Having determined the time of high water by applying the establishment to the time of moon's transit, the navigator may obtain the time of low water with a fair degree of approximation by adding or subtracting 6$^h$ 13$^m$ (one-fourth of a mean lunar day); but a closer result will be given by applying to the time of transit the *mean low water lunitidal interval*, which occupies the same relation to the time of low water as the mean high water lunitidal interval, or corrected establishment, does to the time of high water.

**498.** RANGE.—The *range* of the tide is the difference in height between low water and high water. This term is often applied to the difference existing under average conditions, and may in such a case be designated as the *mean range* or *mean rise and fall* to distinguish it from the *spring range* or *neap range*, which are the ranges at spring and neap tides, respectively.

**499.** SPRING AND NEAP TIDES.—At the times of new and full moon the relative positions of sun and moon are such that the high water produced by one of those bodies occurs at the same time as that produced by the other, and so also with the low waters; the tides then occurring, called *spring tides*, have a greater range than any others of the lunar month, and at such times the highest high tides as well as the lowest low tides are experienced, the tidal range being then at its maximum. At the first and third quarters of the moon the positions are such that the high tide due to one body occurs at the time of the low tide due to the other, so that the two actions are opposed; this causes the *neap tides*, which are those of minimum range, the high waters being lower and the low waters higher than at other periods of the month.

Since the horizontal motion of the water depends directly upon the rise and fall of the tides, it follows that the currents will be greatest at springs and least at neaps.

The effect of the moon's being at full or change is not felt at once in all parts of the world, and the greatest range of tides does not generally occur until one or two days thereafter; thus, on the Atlantic coast of North America, the highest tides are experienced one day, and on the Atlantic coast of Europe, two days afterward, though on the Pacific coast of North America they occur nearly at full and change.

**500.** The nearer the moon is to the earth the stronger is its attraction, and as it is nearest in perigee, the tides will be larger then on that account, and consequently less in apogee. For a like reason, the tides will be increased by the sun's action when the earth is near its perihelion, about the 1st of January, and decreased when near its aphelion, about the 1st of July.

**501.** The height of the tides at any place may undergo modification on account of strong prevailing winds or abnormal barometric conditions, a wind blowing off the shore or a high barometer tending to reduce the tides, and the reverse. The effect of atmospheric pressure is to create a difference of about 2 inches in the height of tide for every tenth of an inch of difference in the barometer.

**502.** Priming and Lagging.—The *tidal day* is the variable interval, averaging $24^h 50^m$, between two alternate high or low waters. The amount by which corresponding tides grow later day by day—that is, the amount by which the tidal day exceeds $24^h$—is called the *daily retardation*. When the sun's tidal effect is such as to shorten the lunitidal intervals, thus reducing the length of the tidal day and causing the tides to occur earlier than usual, there is said to be a *priming* of the tide; when, from similar causes, the interval is lengthened, there is said to be a *lagging*.

**503.** Types of Tides.—The observed tide is not a simple wave; it is a compound of several elementary undulations, rising and falling from the same common plane, of which two can be distinguished and separated by a simple grouping of the data. These two waves are known as the *semi-diurnal* and the *diurnal* tides, because the first, if alone, would give two high and two low waters in a day, while the second would give but one high and one low water in an equivalent period of time. In nearly all ports these two tides coexist, but the proportion between them varies remarkably for different seas. The effect of the combination of these two types of tide is to produce a *diurnal inequality*, both in the height of two consecutive high or low waters, and in the intervals of time between their occurrence. The height of the diurnal wave may be regarded as reaching a maximum fortnightly, soon after the moon attains its extreme declination and is therefore near one of the tropics. The tides that then occur are denominated *tropic tides*.

In undertaking to investigate the tides of a port it is important to ascertain as early as possible the form of the tide; that is, whether it resembles the semi-diurnal, the diurnal, or the mixed type; because not only may this information be of scientific value, but the knowledge thus gained at the outset will enable the observer to fix upon the best method of keeping his record.



——— Semi-diurnal.    - - - - diurnal.    ——- - - ——— mixed.
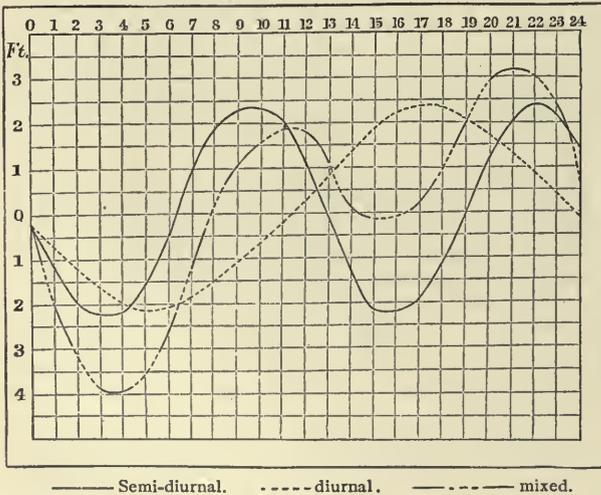
Fig. 64.

**504.** The type forms referred to are illustrated in the diagram in figure 64, where the waves are plotted in curves, using the times as abscissæ and the heights as ordinates. In this diagram, the curve traced in the full line is a tide-wave of the semi-diurnal type; that traced by the dotted line one of the diurnal; while the broken line is one of the mixed type, in this case the compound of the two others.

In order to determine the type to which the tide of any port belongs, it is usually only necessary to make hourly observations for a day or two at the date of the moon's maximum declination, and to repeat the series about a week later, when the moon crosses the equator. The reported irregularities of the rise and fall at any place should not deter persons from careful investigation. When analyzed, even the most complicated of tides are found to follow some general law.

**505.** Tidal Currents.—It should be clearly borne in mind by the navigator that the periods of flood and ebb currents do not necessarily coincide with those of rising and falling tides, and that, paradoxical though it may seem at first thought, the inward set of the surface current does not always cease when the water has attained its maximum height, nor the outward set when a minimum height has been reached. Under some circumstances it may occur that stand and slack will be simultaneous, while other conditions may produce a maximum current at stand, with a maximum rate of rise or fall at slack water.

The varying effects which will be produced according to local conditions may be considered by the comparison of two tidal basins, to one of which the tide-wave has access from the sea by a channel of ample capacity, while the other has an entrance that is narrow and constricted. In the first case, the process of filling or emptying the basin keeps pace with the change of level in the sea and is practically completed as soon as the height without becomes stationary; in this case slack and stand occur nearly at the same time, as do flood and rise and ebb and fall. In the second case, the limited capacity of the entrance will not permit the basin to fill or empty as rapidly as the tide changes its level without;

hence there is still a difference of level to produce a current when the vertical motion in either direction has ceased on the outside, and for a considerable time after motion in the reverse direction has been in progress; under extreme conditions it may even occur that a common level will not be established until mid-tide, and therefore the surface current at some places will ebb until three hours after low water and flow until three hours after high water.

Localities that partake of the nature of the first case are those upon open coasts and wide-mouthed bights. Examples of the latter class will be found in narrow bays and long channels.

## TIMES OF HIGH AND LOW WATER.

**506.** TIDE TABLES.—The most expeditious, as well as most exact, method of ascertaining the times of high and low water and other features of the tides will be by reference to a *Tide Table*, and every navigator is recommended to provide himself with such a publication. The United States Coast and Geodetic Survey publishes annually, in advance, tables giving, for every day in the year, the predicted time and height of the tides at certain principal ports of the world, and from these, by a simple reduction, the times and heights at a multitude of other ports may readily be obtained; data for ascertaining the tidal currents in certain important regions are also provided. General tide tables are also published by the governments of other maritime nations, and special tables are to be had for many particular localities.

**507.** Where no tide tables are available, the method of calculation by applying the lunitidal interval to the time of the moon's meridian passage must be resorted to.

To do this, find first the time of the moon's meridian passage, upper or lower, as may be required. The Greenwich mean time of upper transit at Greenwich is given in the Nautical Almanac (page IV of the month); the corresponding time of lower transit is most easily found by taking the mean of the two adjacent upper transits; to the Greenwich time of Greenwich transit apply the correction for longitude given in Table 11 (using the daily variation of the moon's meridian passage shown in the Almanac). adding in west and subtracting in east longitude; the result is the local mean time of local transit. Add to this the high-water or low-water lunitidal interval of the port from Appendix IV, according as the time of high or low water may be required. The result is the time sought.

The astronomical date must be strictly adhered to, and in so doing it may be found necessary to employ the time of a lower transit, or the transit of a preceding day, to find the time of the tide in question.

Appendix IV contains, besides the geographical positions of all the more important positions in the world, a series of tidal data relating to many of those places. In such data are comprised the mean lunitidal intervals for high and low water; also, for places where the semi-diurnal type of tide prevails, the tidal range at spring and at neap tides, and for those where the tide is of the diurnal type, the tropic range. An alphabetical index is appended to this table.

The corrected establishment taken from the charts may be substituted for the high-water lunitidal interval of the table; or, with only slight variation in the results, the vulgar establishment (H. W. F. & C.) may be employed.

EXAMPLE: Find the times of the high and low waters at the New York navy yard, occurring next after noon on April 22, 1879.

$$
\begin{array}{ll}
\text{G. M. T. of Gr. transit,} & 22^{\text{d}}\ 0^{\text{h}}\ 22^{\text{m}}.2 \\
\text{Corr. for } +74^{\circ} \text{ Long. (Tab. 11), } + & 10 \\
\hline
\text{L. M. T. of local transit,} & 22\ 0\ 42
\end{array}
$$

| Transit, | $22^{\text{d}}\ 0^{\text{h}}\ 42^{\text{m}}$ | | Transit, | $22^{\text{d}}\ 0^{\text{h}}\ 42^{\text{m}}$ |
| H. W. Lun. Int. (App. IV), | 8 44 | | L. W. Lun. Int. (App. IV), | 2 49 |
| L. M. T., H. W., | $\left\{ \begin{array}{l} 22\ 9\ 26 \\ \text{April 22, 9.26 p. m.} \end{array} \right.$ | | L. M. T., L. W., | $\left\{ \begin{array}{l} 22\ 3\ 31 \\ \text{April 22, 3.31 p. m.} \end{array} \right.$ |

EXAMPLE: Find the time of high water at the Presidio, San Francisco, Cal., on the afternoon of May 7, 1879.

$$
\begin{array}{ll}
\text{G. M. T. of Gr. transit,} & 6^{\text{d}}\ 12^{\text{h}}\ 36^{\text{m}}.6 \\
\text{Corr. for } +122^{\circ} \text{ Long. (Tab. 11), } + & 22 \\
\hline
\text{L. M. T. of local transit,} & 6\ 12\ 59 \\
\text{H. W. Lun. Int. (App. IV),} \quad + & 11\ 43 \\
\hline
\text{L. M. T., H. W.,} & \left\{ \begin{array}{l} 7\ 0\ 42 \\ \text{May 7, 12.42 p. m.} \end{array} \right.
\end{array}
$$

EXAMPLE: Find the time of low water at Singapore on the night of May 28, 1879.

$$
\begin{array}{ll}
\text{G. M. T. of Gr. transit,} & 28^{\text{d}}\ 5^{\text{h}}\ 55^{\text{m}}.3 \\
\text{Corr. for } -104^{\circ} \text{ Long. (Tab. 11), } - & 13 \\
\hline
\text{L. M. T. of local transit,} & 28\ 5\ 42 \\
\text{L. W. Lun. Int. (App. IV),} \quad + & 4\ 02 \\
\hline
\text{L. M. T., L. W.,} & \left\{ \begin{array}{l} 28\ 9\ 44 \\ \text{May 28, 9.44 p. m.} \end{array} \right.
\end{array}
$$

EXAMPLE: Find the time of morning high water and afternoon low water at Gibraltar on June 26, 1879.

$$
\begin{array}{lr}
\text{G. M. T. of Gr. upper transit,} & 25^d \quad 4^h \; 40^m.1 \\
\text{G. M. T. of Gr. upper transit,} & 26 \quad 5 \quad 27 \;.0 \\
\hline
& 2)51 \; 10 \; 07 \;.1 \\
\hline
\text{G. M. T. of Gr. lower transit,} & 25 \; 17 \; 04 \\
\text{Corr. for} + 5° \text{ Long. (Tab. 11),} + & 01 \\
\hline
\text{L. M. T. of local lower trans.,} & 25 \; 17 \; 05
\end{array}
$$

| Transit, | $25^d 17^h 05^m$ | Transit, | $25^d 17^h 05^m$ |
|---|---|---|---|
| H. W. Lun. Int. (App. IV), | 1  35 | L. W. Lun. Int. (App. IV), | 7  55 |
| L. M. T., H. W., | $\left\{\begin{array}{l} 25 \; 18 \; 40 \\ \text{June 26, 6.40 a. m.} \end{array}\right.$ | L. M. T., L. W., | $\left\{\begin{array}{l} 26 \; 1 \; 00 \\ \text{June 26, 1 p. m.} \end{array}\right.$ |

## TIDAL OBSERVATIONS.

**508.** Since navigators will frequently have opportunity to observe tidal conditions, either in connection with a hydrographic survey or otherwise, at places where existing knowledge of the tides is incomplete, an understanding of the methods employed in tidal observations may be important.

**509.** TIDES.—For the proper study of tides, frequent and continuous observations are necessary; it will not suffice to observe the heights of the high and low waters only, even if they present themselves as distinct phases, but the whole tidal curve for each day should be developed by recording the height of water at intervals, which, preferably, should not exceed thirty minutes. Observations, to be complete, must cover a whole lunar month; or, if it be impracticable to observe the tides at night, the day tides of two lunar months may be substituted.

**510.** When made for the purposes of a hydrographic survey the tidal observations are used to correct the soundings, and care must be taken to make sure that the gauge is placed in a situation visited by the same form of tide as that which occurs at the place where soundings are being made. It will not answer, for instance, to correct the soundings upon an inlet-bar by tidal observations made within the lagoon with which this inlet communicates, because the range of the tide within the lagoon is less than upon the outside coast. A partial obstruction, like a bridge, or a natural contraction of the channel section, while it may not reduce the total range of the tide or materially affect the time of high or low tides, will alter the relative heights above and below at intermediate stages, so that the hydrographer must be careful to see that no such obstruction intervenes between his field of work and the gauge.

**511.** TIDAL CURRENTS.—Observations for tidal currents should be made with the same regularity as for tides; the intervals need not ordinarily be more frequent than once in every half hour. They should always be made at the same point or points, which should be far enough from shore to be representative of the conditions prevailing in the navigable waters. The ordinary log may be employed for measuring the current, but it is better to replace the chip by a pole weighted to float upright at a depth of about fifteen feet; the line should be a very light one, and buoyed at intervals by cork floats to keep it from sinking; the set of the current should be noted by a compass bearing of the direction of the pole at the end of the observation.

**512.** RECORD.—The record of observations should be kept clearly and in complete form. It should include a description of the locality of observation, the nature of gauge and of instruments used for measuring currents, and the exact position of both tidal and current stations, together with situation and height of bench mark. The time of making each observation should be shown, and data given for reduction to some standard time. In extended tidal observations the meteorological conditions should be carefully recorded, the instruments used for the observations being properly compared with standards.

**513.** There are frequently remarkable facts in reference to tides and currents to be obtained from persons having local knowledge; these should be examined and recorded. The date and circumstances of the highest and lowest tides ever known form important items of information.

**514.** PLANES OF REFERENCE.—The *plane of reference* is the plane to which soundings and tidal data are referred. One of the principal objects of observing tides when making a survey is to furnish the means for reducing the soundings to this plane. Four planes of reference are used; namely, mean low water, mean low water springs, mean lower low waters, and the harmonic or Indian tide plane.

*Mean low water* is a plane whose depression below mean sea level corresponds with half the mean semi-diurnal range, while the depression of *mean low-water springs* corresponds with half the mean range of spring tide; *mean lower low water* depends upon the diurnal inequality in high and low water; the *harmonic* or *Indian tide plane* was adopted as a convenient means of expressing something of an approximation to the level of low water of ordinary spring tides, but where there is a large diurnal inequality in low waters it falls considerably below the true mean of such tides.

As these planes may differ considerably, it is important to ascertain which plane of reference is adopted before making use of any chart or considering data concerning the tides.

**515.** The tides are subject to so many variations dependent upon the movements of the sun and moon, and to so many irregularities due to the action of winds and river outflows, that a very long series of observations would be necessary to fix any natural plane. In consideration of this, and keeping in view the possibilities of repetitions of the surveys or subsequent discoveries within the field of work, it is necessary to define the position of the plane of reference which has resulted from any series of observations. This is done by leveling from the tide gauge to a permanent *bench*, precisely as if the adopted plane were arbitrary.

**516.** BENCH MARK.—The plinth of a light-house, the water table of a substantial building, the base of a monument, and the like, are proper benches; and when these are not within reach, a mark

may be made on a rock not likely to be moved or started by the frost, or, if no rock naturally exists in the neighborhood, a block of stone buried below the reach of frost and plowshare should be the resort. When a bench is made on shore, it should be marked by a circle of 2 or 3 inches diameter with a cross in the center, indicating the reference point. The levelings between this point and the gauge should be be run over twice and the details recorded. A bench made upon a wharf or other perishable structure is of little value, but in the absence of permanent objects it is better than nothing. The marks should be cut in, if on stone, and if on wood, copper nails should be used. The bench must be sketched and carefully described, and its location marked on the hydrographic sheet, with a statement of the relative position of the plane of reference.

**517.** The leveling from the bench mark to the tide gauge may be done, when a leveling instrument is not available, by measuring the difference of height of a number of intermediate points by means of a long straight-edged board, held horizontal by the aid of a carpenter's spirit level, or even a plummet square, taking care to repeat each step with the level inverted end for end. A line of sight to the sea horizon, when it can be seen from the bench across the tide staff, will afford a level line of sufficient accuracy, especially when observed with the telescope. It may often be convenient to combine these methods.

**518.** Tide Gauges.—The *Staff Gauge* is the simplest device for measuring the heights of tides, and in perfectly sheltered localities it is the best. It consists of a vertical staff graduated upward in feet and tenths, and so placed that its zero shall lie below the lowest tides. The same gauge may also be used where the surface is rough, if a glass tube with a float inside is secured alongside of the staff, care being taken to practically close the lower end of the tube so as to exclude undulations; readings may also be made by noting the point midway between the crest and trough of the waves.

A staff gauge should always be erected for careful tidal observations, even where other classes of gauge are to be employed, as it furnishes a standard for comparison of absolute heights, and also serves to detect any defects in the mechanical details upon which all other gauges are to a greater or less extent dependent.

**519.** Where there is considerable swell, and where, from the situation of the gauge or the great range of the tide (making it inconvenient for the observer to see the figures in certain positions) the staff gauge can not be used, recourse must be had to the *Box Gauge*. This gauge consists of a vertical box, closed at the bottom, with a few small holes in the lower part which admit sufficient water to keep the level within equal to the mean level without, but which do not permit the admission of water with sufficient rapidity to be affected by the waves. Within the box is a copper float; in some cases this float carries a graduated vertical rod whose position with reference to a fixed point of the box affords a measure for the height of the water; in other gauges of this class the float is attached to a wire or cord which passes over pulleys and terminates in a counterpoise whose position on a vertical graduated scale shows the height of tide.

**520.** An *Automatic Gauge* requires a box and float such as has just been described. The motion of the float in rising and falling with the tide is communicated to a pencil which rests upon a moving sheet of paper; uniform motion is imparted to the paper by the revolution of a cylinder driven by clock-work; the motion of the pencil due to the tide is in a direction perpendicular to the direction of motion of the paper, and a curve is thus traced, of which one coordinate is time, and the other height. The paper, which is usually of sufficient length to contain a month's record, is paid out from one cylinder, passes over a second whereon it receives the record, and is rolled upon a third cylinder, which thus contains the completed tidal sheet.

This gauge, besides giving a perfectly continuous record, has the further merit of requiring but little of the observer's time. But its indications, both of time and heights, should be checked by occasional comparisons with the standard clock and the staff gauge, the readings of which should be noted by hand at appropriate points of the graphic record.

# CHAPTER XXI.

## OCEAN CURRENTS.

**521.** An *ocean current* is a progressive horizontal motion of the water occurring throughout a region of the ocean, as a result of which all bodies floating therein are carried with the stream.

The *set* of a current is the direction toward which it flows, and its *drift*, the velocity of the flow.

**522.** Cause.—The principal *cause* of ocean currents is the wind. Every breeze sets in motion, by its friction, the surface particles of the water over which it blows; this motion of the upper stratum is imparted to the stratum next beneath, and thus the general movement is communicated, each layer of particles acting upon the one below it, until a current is established. The direction, depth, strength, and permanence of such a current will depend upon the direction, steadiness, and force of the wind; all, however, subject to modification on account of extraneous causes, such as the intervention of land or shoals and the meeting of conflicting currents.

A minor cause in the generation of ocean currents is the difference in density of the sea water in different regions, as a result of which a set is produced from the more dense toward the less dense, in the effort to establish equilibrium of pressure; the difference of density may be due to temperature, the warmer water near the equator being less dense than the colder water of higher latitudes; or it may be created by a difference in the amount of contained saline matter, resulting from evaporation, freezing, or other causes. Another minor factor that may have influence upon ocean currents is the difference of pressure exerted by the atmosphere upon the water in different regions. But neither of the last-mentioned causes may be regarded as of great importance when compared with the influence, direct and indirect, of the wind.

**523.** Drift and Stream Currents.—Ocean currents may be divided into two classes: *Drift* and *Stream Currents*.

A *Drift Current* is one which arises from the effect of wind upon the surface water, impelling the particles to leeward. Such currents reach only to shallow depths, except in regions where caused by winds whose prevalence is almost unbroken, and where, in consequence, motion is communicated stratum by stratum, during a long series of years, until the influence is felt at great depths.

A *Stream Current* is one which arises when the water carried forward by a drift current encounters an obstacle which prevents a further flow in the direction which it has been following, and the particles are forced to acquire a new motion which takes such direction as may be imposed by the conditions existing in the locality.

Some currents are compounded of both drift and stream; for a stream already formed may pass through the region of a prevalent wind in such direction that it will receive an accelerating effect due to the wind.

**524.** Submarine Currents.—In any scientific investigation of the circulation of ocean waters it is necessary to take account of the submarine currents as well as those encountered upon the surface; but for the practical purposes of the navigator the surface currents alone are of interest.

**525.** Methods of Determination.—The methods of determining the existence of a current, with its set and drift, may be divided into three classes; namely, (*a*) by observations from a vessel occupying a stationary position not affected by the current; (*b*) by comparison of the position of a vessel under way as given by observation with that given by dead reckoning; and (*c*) by the drift of objects abandoned to the current in one locality and reappearing in another.

**526.** Of these methods, the first named, by observations from a vessel at anchor, is by far the most accurate and reliable, but being possible only under special circumstances is not often available. The most valuable information about ocean currents being that which pertains to conditions in the open sea, the great depths there existing usually preclude the possibility of anchoring a vessel; ships especially fitted for the purpose have at times, however, carried out current observations with excellent results; the most notable achievements in this direction are those of the survey of the Gulf Stream, made by United States naval officers acting under the Coast and Geodetic Survey, during which the vessel was anchored and observations were made in positions where the depth reached to upward of 2,000 fathoms.

**527.** The method of determining current from a comparison of positions obtained, respectively, by observation and by dead reckoning is the one upon which our knowledge must largely depend. This method is, however, always subject to some inaccuracy, and the results are frequently quite erroneous, for the so-called current is thus made to embrace not only the real set and drift, but also the errors of observation and dead reckoning. In the case of a modern steamer accurately steered and equipped with good instruments for determining the speed through the water as well as the position by astronomical observations, the current may be arrived at by this method with a fairly close degree of accuracy. It is not always possible, however, to keep an exact reckoning, and this is especially true in sailing vessels, where the conditions render it difficult to determine correctly the position by account; this source of error may be combined with faulty instrumental determinations, giving apparent currents differing widely from those that really exist.

**528.** Much useful knowledge regarding ocean currents has been derived from the observed drift of objects from one to another locality. This is true not only of the bottles thrown overboard from vessels with the particular object of determining the currents, but also of derelicts, drifting buoys, and pieces

of wreckage, which fulfill a similar mission. The deductions to be drawn from such drift are of a general nature only. The point of departure, point of arrival, and elapsed time are all that are positively known. The route followed and the set and drift of current at different points are not indicated, and in the case of objects floating otherwise than in a completely submerged condition account must be taken of the fact that the drift is influenced by the wind. But even this general information is of great value in researches as to ocean currents, and navigators who desire to aid in the work of investigation may do so by throwing overboard, from time to time, sealed bottles containing a statement of date and position at which they are launched.

**529.** Currents of the Atlantic Ocean.—A consideration of the currents of the Atlantic most conveniently begins with a description of the *Equatorial Currents*. The effect of the northeast and southeast trade winds is to form two great drift currents, setting in a westerly direction across the Atlantic from Africa toward the American continent, whose combined width covers at times upward of fifty degrees of latitude. These are distinguished as the *Northern* or *Southern Equatorial Currents*, according as they arise from the trade winds of the northern or southern hemisphere.

Of the two, the Southern Equatorial Current is the more extensive. It has its origin off the continent of Africa south of the Guinea coast, and begins its flow with a daily velocity that averages about 15 miles; it maintains a general set of west, the portion near the equator acquiring later, however, a northerly component, while the drift steadily increases until, on arriving off the South American coast, a rate of 60 miles is not uncommon. At Cape San Roque the current bifurcates, the main or equatorial branch flowing along the Guiana coast, while the other branch is deflected to the southward.

The Northern Equatorial Current originates to the northward of the Cape Verde Islands and sets across the ocean in a direction that averages due west; though parallel to the corresponding southern drift, its velocity is not so high.

**530.** Between the Northern and Southern Equatorial Currents is found the *Equatorial Counter Current*, which sets to the eastward, being apparently a flowing back, in the region of equatorial calms, of water carried westward by the trade drifts. The extent and strength of this current varies with the season, a maximum being attained in July or August, when its effect is apparent to the westward of the fiftieth meridian of west longitude, while at its minimum, in November or December, its influence is but slight and prevails over a limited area only.

**531.** To the westward of the region of the Equatorial Counter Current the North and the South Equatorial Currents unite. A large part of the combined stream flows into the Caribbean Sea through the various passages between the Windward Islands, takes up a course first to the westward and then to the northward and westward, finally arriving off the extremity of the peninsula of Yucatan; from here some of the water follows the shore line of the Gulf of Mexico, while another portion passes directly toward the north Cuban coast; by the reuniting of these two branches in the Straits of Florida there is formed the most remarkable of all ocean currents—the Gulf Stream.

From that portion of the combined equatorial currents which fails to find entrance to the Caribbean Sea a current of moderate strength and volume takes its course along the north coasts of Porto Rico, Haiti, and Cuba, flows between the last-named island and the Bahamas, and enters the Gulf Stream off the Florida coast, thus adding its waters to those of the main branch of the equatorial current which have arrived at the same point by way of the Caribbean, the Yucatan Passage, and the Gulf.

**532.** The *Gulf Stream*, which has its origin, as has been described, in the Straits of Florida, and receives an accession from a branch of the Equatorial Current off the Bahamas, flows in a direction that averages true north as far as the parallel of 31°, then curves sharply to ENE. until reaching the latitude of 32°, when a direction a little to the north of NE. is assumed and maintained as far as Cape Hatteras; at this point its axis is about 40 miles, while its inner edge is in the neighborhood of 20 miles off the shore. Thus far in its flow the average position of the maximum current is from 11 to 20 miles outside the 100-fathom curve, disregarding the irregularities of the latter, and the width of the stream—about 40 miles—is nearly uniform. From off Hatteras the stream broadens rapidly and curves more to the eastward, seeking deeper water; its northern limit may be stated to be 60 to 80 miles off Nantucket Shoals and 120 to 150 miles to the southward of Nova Scotia, in which latter place it has expanded to a width of about 250 miles. Further on, its identity as the Gulf Stream is lost, but its general direction is preserved in a current to be described later.

The water of the Gulf Stream is of a deep indigo-blue color, and its junction with ordinary sea water may be plainly recognized; in moderate weather the edges of the stream are marked by ripples; in cool regions the evaporation from its surface, due to difference of temperature between air and water, is apparent to the eye; the stream carries with it a quantity of weed known as "gulf weed," which is familiar to all who have navigated its waters.

In its progress from the tropics to higher latitudes the transit is so rapid that time is not given for more than a partial cooling of the water, and it is therefore found that the Gulf Stream is very much warmer than the neighboring waters of the seas through which it flows. This warm water is, however, divided by bands of markedly cooler water which extend in a direction parallel to the axis and are usually found near the edges of the stream of warm water. The most abrupt change from warm to cold water occurs on the inshore side, where the name of the *Cold Wall* has been given to that band which has appeared to some oceanographers to form the northern and western boundary of the stream.

The investigations of Pillsbury tend to prove that the thermometer is only an approximate guide to the direction and velocity of the current. Though it indicates the limits of the stream in a general way, it must not be assumed that the greatest velocity of flow coincides with the highest temperature, nor that the northeasterly set will be lost when the thermometer shows a region of cold sea water.

The same authority has also demonstrated that in the vicinity of the land there is a marked variation in the velocity of current at different hours of the day, which may amount to upward of 2 knots, and which is due to the elevation and depression of the sea as a result of tidal influences, the maximum current being encountered at a period which averages about three hours after the moon's transit. Another effect noted is that at those times when the moon is near the equator the current presents a narrow front with very high velocity in the axis of maximum strength, while at periods of great northerly or

southerly declination the front broadens, the current decreasing at the axis and increasing at the edges. These tidal effects are not, however, observed in the open sea.

The velocity of the Gulf Stream varies with the seasons, following the variation in the intensity of the trade winds, to which it largely owes its origin. The drift of the current under average conditions may be stated as follows:

Between Key West and Habana: Mean surface velocity in axis of maximum current, 2¼ knots; allowance to be made by a vessel crossing the entire width of the stream, 1.1 knots per hour.

Off Fowey Rocks: Mean surface velocity in axis, 3.5 knots; allowance in crossing, 2¼ knots per hour.

Off Cape Hatteras: Mean surface velocity in axis, upward of 2 knots; allowance in crossing the stream, 1½ knots per hour between the 100-fathom curve and a point 40 miles outside that curve.

**533.** After passing beyond the longitude of the easternmost portions of North America, it is generally regarded that the Gulf Stream, as such, ceases to exist; but by reason of the prevalence of westerly winds the direction of the set toward Europe is continued until the continental shores are approached, when the current divides, one branch going to the northeastward and entering the Arctic regions and the other running off toward the south and east in the direction of the African coast. These currents have received, respectively, the designations of the *Easterly*, *Northeast*, and *Southeast Drift Currents*.

**534.** The effect of the currents thus far described is to create a general circulation of the surface waters of the North Atlantic, in a direction coinciding with that of the hands of a watch, about the periphery of a huge ellipse, whose limits of latitude may be considered as 10° N. and 45° N., and which is bounded in longitude by the Eastern and Western continents. The central space thus inclosed, in which no well-marked currents are observed, and in the waters of which great quantities of the Sargasso or gulf weed are encountered, is known as the *Sargasso Sea*.

**535.** The Southeast Drift Current carries its waters to the northwest coast of Africa, whence they follow the general trend of the land from Cape Spartel to Cape Verde. From this point a large part of the current is deflected to the eastward close along the upper Guinea coast. The steam thus formed, greatly augmented at certain seasons by the prevailing monsoon and by the waters carried eastward with the Equatorial Counter Current, is called the *Guinea Current*. A remarkable characteristic of this current is the fact that its southern limit is only slightly removed from the northern edge of the west-moving Equatorial Current, the effect being that the two currents flow side by side in close proximity, but in diametrically opposite directions.

**536.** The *Arctic* or *Labrador Current* sets out of Davis Strait, flows southward down the coasts of Labrador and Newfoundland, and thence southwestward past Nova Scotia and the coast of the United States, being found inshore of the Gulf Stream. It brings with it the ice so frequently met at certain seasons off Newfoundland.

**537.** *Rennell's Current* is a temporary but extensive stream, which sets at times from the Bay of Biscay toward the west and northwest, across the entrance to the English Channel and to the westward of Cape Clear.

**538.** Of the two branches of the Southern Equatorial Current which are formed by its bifurcation off Cape San Roque, the northern one, setting along the coasts of northeastern Brazil and of Guiana and contributing to the formation of the Gulf Stream, has already been described; the other, known as the *Brazil Current*, flows to south and west, along the southeastern coast of Brazil, as far as the neighborhood of the island of Trinidad; here it divides, one part continuing down the coast and having some slight influence as far as the latitude of 45° S., and the other curving around toward east.

**539.** The last-mentioned branch of the Brazil Current is called the *Southern Connecting Current* and flows toward the African coast in about the latitude of Tristan d'Acunha. It then joins its waters with those of the general northerly current that sets out of the Antarctic region, forming a current which flows to the northward along the southwest African coast and eventually connects with the Southern Equatorial Current, thus completing the surface circulation of the South Atlantic.

**540.** There are two other currents whose effects are felt in the Atlantic, one originating in the Indian Ocean and flowing around the Cape of Good Hope, the other originating in the Pacific and flowing around Cape Horn. They will be described under the currents of the oceans in which they first appear.

**541.** CURRENTS OF THE PACIFIC OCEAN.—As in the Atlantic, the waters of the Pacific Ocean, in the region between the tropics, have a general drift toward the westward, due to the effect of the trade winds, the currents produced in the two hemispheres being denominated, respectively, the *Northern* and the *Southern Equatorial Currents*. These are separated, as also in the case of the Atlantic, by an east-setting stream, about 300 miles wide, whose mean position is a few degrees north of the equator, and which receives the name of the *Equatorial Counter Current*.

**542.** The major portion of the Northern Equatorial Current, after having passed the Mariana Islands, flows toward the eastern coast of Formosa in a WNW. direction, whence it is deflected northward, forming a current which is sometimes called the *Japan Stream*, but which more frequently receives its Japanese name of *Kuro Siwo*, or "black stream." This current, the waters of which are dark in color and contain a variety of seaweed similar to "gulf weed," carries the warm tropical water at a rapid rate to the northward and eastward along the coasts of Asia and its offlying islands, presenting many analogies to the Gulf Stream of the Atlantic.

The limits and volume of the Kuro Siwo vary according to the monsoon, being augmented during the season of southwesterly winds and diminished during the prevalence of those from northeast. The current sets to the north along the east coast of Formosa, and in about latitude 26° N. changes its course to northeast, arriving at the extreme southwestern point of Japan by a route to westward of the Meiaco-sima and Loo-choo islands. A branch makes off from the main stream to follow northward along the west coast of Japan, entering the Sea of Japan by the Korea Channel; but the principal current bends toward the east, flows through Van Diemen Strait and the passages between the Linschoten Isles, and runs parallel to the general trend of the south shores of the Japanese islands of Kiushu, Sikok, and Nipon, attaining its greatest velocity between Bungo and Kii channels, where its average drift is between 2 and 3 knots per hour. Continuing beyond the southeastern extremity of Nipon, the direction

of the stream becomes somewhat more northerly, and its width increases, with consequent loss of velocity. In the Kuro Siwo, as in the Gulf Stream, the temperature of the sea water is an approximate, though not an exact, guide as to the existence of the current.

**543.** Near 146° or 147° E. and north of the fortieth parallel the Kuro Siwo divides into two parts. One of these, called the *Kamchatka Current*, flows to the northeast in the direction of the Aleutian Islands, and its influence is felt to a high latitude. The second branch continues as the main stream, and maintains a general easterly direction to the 180th meridian, where it is merged into the north and northeast drift currents which are generally encountered in this region.

**544.** A cold counter current to the Kamchatka Current sets out of Bering Sea and flows to the south and west close to the shores of the Kuril Islands, Yezo and Nipon, sometimes, like the Labrador Current in the Atlantic, bringing with it quantities of Arctic ice. This is often called by its Japanese name of *Oya Siwo*.

**545.** On the Pacific coast of North America, from about 50° N. to the mouth of the Gulf of California, 23° N., a cold current, 200 or 300 miles wide, flows with a mean speed of three-quarters of a knot, being generally stronger near the land than at sea. It follows the trend of the land (nearly SSE.) as far as Point Concepcion (south of Monterey), when it begins to bend toward SSW., and then to WSW., off Capes San Blas and San Lucas, ultimately joining the great northern equatorial drift.

On the coast of Mexico, from Cape Corrientes (20° N.) to Cape Blanco (Gulf of Nicoya), there are alternate currents extending over a space of more than 300 miles in width, which appear to be produced by the prevailing winds. During the dry season—January, February, and March—the currents generally set toward southeast; during the rainy season—from May to October—especially in July, August, and September, the currents set to northwest, particularly from Cosas Island and the Gulf of Nicoya to the parallel of 15°.

**546.** The Southern Equatorial Current prevails between limits of latitude that may be approximately given as 4° N. and 10° S., in a broad region extending from the American continent almost to the one hundred and eightieth meridian, setting always to the west and with slowly increasing velocity. In the neighborhood of the Fiji Islands this current divides; one part, known as the *Rossel Current*, continues to the westward, following a route marked by the various passages between the islands, and later acquiring a northerly component and setting through Torres Strait and along the north coast of New Guinea; the other part, called the *Australia Current*, sets toward south and west, arriving off the east coast of Australia, along which it flows southward to about latitude 35° S., whence it bends toward southeast and east and is soon after lost in the currents due to the prevailing wind.

**547.** The general drift current that sets to the north out of the Antarctic regions is deflected until, upon gaining the regions to the southwest of Patagonia, it has acquired a nearly easterly set; in striking the shores of the South American continent it is divided into two branches.

The first, known as the *Cape Horn Current*, maintains the general easterly direction, and its influence is felt, where not modified by winds and tidal currents, throughout the vicinity of Cape Horn, and, in the Atlantic Ocean, off the Falkland Islands and eastern Patagonia.

The second branch flows northeast in the direction of Valdivia and Valparaiso, follows generally the direction of the coast lines of Chile and Peru (though at times setting directly toward the shore in such manner as to constitute a great danger to the navigator), and forms the important current which has been called variously the *Peruvian, Chilean*, or *Humboldt Current*, the last name having been given for the distinguished scientist who first noted its existence. The principal characteristic of the Peruvian Current is its relatively low temperature. The direction of the waters between Pisco and Payta is between north and northwest; near Cape Blanco the current leaves the coast of America and bears toward the Galapagos Islands, passing them on both the northern and southern sides; here it sets toward WNW. and west; beyond the meridian of the Galapagos it widens rapidly, and the current is lost in the equatorial current, near 108° W. As often happens in similar cases, the existence of a counter-current has been proved on different occasions; this sets toward the south, is very irregular, and extends only a little distance from shore.

**548.** CURRENTS OF THE INDIAN OCEAN.—In this ocean the currents to the north of the equator are very irregular; the periodical winds, the alternating breezes, and the changes of monsoon produce currents of a variable nature, their direction depending upon that of the wind which produces them, upon the form of neighboring coasts, or, at times, upon causes which can not be satisfactorily explained.

**549.** There is, in the Indian Ocean south of the equator, a regular *Equatorial Current* which, by reason of owing its source to the southeast trade winds, corresponds with the Southern Equatorial Currents of the Atlantic and Pacific. The limits of this west-moving current vary with the longitude as well as with the season. Upon reaching about the meridian of Rodriguez Island, a branch makes off toward the south and west, flowing past Mauritius, then to the south of Madagascar (on the meridian of which it is 480 miles broad), and thereafter, rapidly diminishing its breadth, forming part of the Agulhas Current a little to the south of Port Natal.

The main equatorial current continues westward until passing the north end of Madagascar, where, encountering the obstruction presented by the African continent, it divides, one branch following the coast in a northerly, the other in a southerly, direction. The former, in the season of the southwest monsoon, is merged into the general easterly and northeasterly drift that prevails throughout the ocean from the northern limit of the Equatorial Current on the south, as far as India and the adjacent Asiatic shores on the north; but during the northeast monsoon, when there exists in the northern regions of the Indian Ocean a westerly drift current analogous to the Northern Equatorial Currents produced in the Atlantic and Pacific by the northeast trades, there is formed an east-setting *Equatorial Counter Current*, which occupies a narrow area near the equator and is made up of the waters accumulated at the western continental boundary of the ocean by the drift currents of both hemispheres.

**550.** The southern branch of the Equatorial Current flows to the south and west down the Mozambique channel, and, being joined in the neighborhood of Port Natal by the stream which arrives from the open ocean, there is formed the warm *Agulhas Current*, which possesses many of the characteristics of the Gulf and Japan streams. This current skirts the east coast of South Africa and

attains considerable velocity over that part between Port Natal and Algoa Bay. During the summer months its effects are felt farther to the westward; during the winter it diminishes in force and extent. The meeting of the Agulhas Current with the cold water of higher latitudes is frequently denoted by a broken and confused sea.

Upon arriving at the southern side of the Agulhas Bank, the major part of the current is deflected to the south, and then curves toward east, flowing back into the Indian Ocean with diminished strength and temperature, on about the fortieth parallel of south latitude, where its influence is felt as far as the eightieth meridian. A small part of the stream which reaches Agulhas Bank continues across the southern edge of that bank, then turns to the northwest along the west coast of the continent until it is united with the waters of the Southern Connecting Current of the Atlantic.

**551.** Along the fortieth parallel of south latitude, between Africa and Australia, there is a general easterly set, due to the branch of the Agulhas current already described, to the continuation of the drift current from the Atlantic which passes to southward of the Cape of Good Hope, and to the westerly winds which largely prevail in this region. At Cape Leeuwin, the southwestern extremity of Australia, this east-setting current is divided into two branches; one, going north along the west coast of Australia, blends with the Equatorial current nearly in the latitude of the Tropic of Capricorn; the other preserves the direction of the original current and has the effect of producing an easterly set along the south coast of Australia.

**552.** As in the other oceans, a general northerly current is observed to set into the Indian Ocean from the Antarctic regions.

# APPENDIX I.

## EXTRACTS FROM THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC, FOR THE YEAR 1879, WHICH HAVE REFERENCE TO THE EXAMPLES FOR THAT YEAR GIVEN IN THIS WORK.

[Extracts: Page I.]

### AT GREENWICH APPARENT NOON.

| Day of the Week. | Day of the Month. | THE SUN'S | | | | | Sidereal Time of the Semidiameter passing the Meridian. | Equation of Time, *to be* | | Diff. for 1 hour. |
| | | *Apparent* Right Ascension. | Diff. for 1 hour. | *Apparent* Declination. | Diff. for 1 hour. | Semidiameter. | | *added to* *subtracted from Apparent Time.* | | |
| | | h. m. s. | s. | ° ′ ″ | ″ | ′ ″ | s. | m. s. | | s. |
| | | | | | | | | | | |
| | | | | JANUARY. | | | | | | |
| Sun. | 19 | 20  4 60.17 | 10.626 | S. 20 21  9.0 | +31.54 | 16 17.58 | 69.72 | 10 56.68 | | 0.769 |
| Mon. | 20 | 20  9 14.84 | 10.595 | 20  8 20.4 | 32.49 | 16 17.48 | 69.61 | 11 14.74 | | 0.738 |
| Tues. | 21 | 20 13 28.75 | 10.564 | S. 19 55  9.1 | +33.43 | 16 17.38 | 69.51 | 11 32.05 | | 0.706 |
| | | | | | | | | | | |
| | | | | APRIL. | | | | | | |
| Tues. | 1 | 0 41 54.87 | 9.096 | N.  4 30 43.2 | +57.85 | 16  2.16 | 64.51 | 4  0.60 | | 0.758 |
| Wed. | 2 | 0 45 33.24 | 9.100 | 4 53 49.1 | 57.64 | 16  1.89 | 64.53 | 3 42.46 | | 0.754 |
| Thur. | 3 | 0 49 11.70 | 9.106 | 5 16 49.8 | 57.41 | 16  1.61 | 64.55 | 3 24.43 | | 0.748 |
| Sun. | 13 | 1 25 47.34 | 9.205 | 9  0 54.1 | 54.40 | 15 58.86 | 64.89 | 0 35.02 | | 0.649 |
| Mon. | 14 | 1 29 28.45 | 9.219 | 9 22 35.4 | 54.03 | 15 58.59 | 64.94 | 0 19.60 | | 0.635 |
| Tues. | 15 | 1 33  9.91 | 9.234 | 9 44  7.5 | 53.64 | 15 58.31 | 64.99 | 0  4.54 | | 0.620 |
| Wed. | 16 | 1 36 51.74 | 9.250 | 10  5 29.9 | 53.23 | 15 58.04 | 65.04 | 0 10.15 | | 0.604 |
| Thur. | 17 | 1 40 33.95 | 9.268 | 10 26 42.3 | 52.80 | 15 57.77 | 65.09 | 0 24.46 | | 0.587 |
| Frid. | 18 | 1 44 16.56 | 9.285 | 10 47 44.7 | 52.37 | 15 57.50 | 65.15 | 0 38.36 | | 0.570 |
| Sat. | 19 | 1 47 59.58 | 9.302 | 11  8 36.4 | 51.92 | 15 57.24 | 65.21 | 0 51.85 | | 0.553 |
| Sun. | 20 | 1 51 43.01 | 9.320 | 11 29 17.1 | 51.45 | 15 56.98 | 65.27 | 1  4.93 | | 0.536 |
| Mon. | 21 | 1 55 26.87 | 9.337 | N. 11 49 46.4 | +50.97 | 15 56.72 | 65.33 | 1 17.60 | | 0.518 |
| | | | | | | | | | | |
| | | | | MAY. | | | | | | |
| Mon. | 5 | 2 48 30.72 | 9.626 | N. 16 13 40.4 | +42.86 | 15 53.36 | 66.37 | 3 25.18 | | 0.229 |
| Tues. | 6 | 2 52 22.03 | 9.650 | 16 30 40.4 | 42.17 | 15 53.14 | 66.45 | 3 30.40 | | 0.206 |
| Sat. | 10 | 3  7 53.03 | 9.747 | 17 35 53.8 | 39.33 | 15 52.25 | 66.78 | 3 45.58 | | 0.109 |
| Sun. | 11 | 3 11 47.27 | 9.771 | 17 51 29.1 | 38.59 | 15 52.03 | 66.86 | 3 47.90 | | 0.084 |
| Thur. | 15 | 3 27 30.07 | 9.871 | 18 50 48.5 | 35.52 | 15 51.20 | 67.19 | 3 51.32 | | 0.014 |
| Frid. | 16 | 3 31 27.26 | 9.895 | 19  4 51.6 | 34.72 | 15 51.00 | 67.27 | 3 50.68 | | 0.039 |
| Sat. | 17 | 3 35 25.03 | 9.919 | 19 18 35.5 | 33.91 | 15 50.80 | 67.35 | 3 49.47 | | 0.062 |
| Sun. | 18 | 3 39 23.37 | 9.942 | N. 19 31 59.8 | +33.06 | 15 50.61 | 67.43 | 3 47.69 | | 0.086 |

NOTE.—Mean Time of the Semidiameter passing may be found by substracting 0ˢ.18 from the Sidereal Time.
 + prefixed to the hourly change of declination indicates that north declinations are increasing and south declinations are decreasing; — indicates that north declinations are decreasing and south declinations are increasing.

[Extracts: Page I.]

## AT GREENWICH APPARENT NOON—Continued.

| Day of the Week. | Day of the Month. | THE SUN'S | | | | | Sidereal Time of the Semidiameter passing the Meridian. | Equation of Time, to be subtracted from added to Apparent Time. | Diff. for 1 hour. |
|---|---|---|---|---|---|---|---|---|---|
| | | Apparent Right Ascension. | Diff. for 1 hour. | Apparent Declination. | Diff. for 1 hour. | Semi-diameter. | | | |
| | | h.  m.  s. | s. | °  ′  ″ | ″ | ′  ″ | s. | m.  s. | s. |
| | | | | JUNE. | | | | | |
| Sat. | 7 | 5  0  33.74 | 10.312 | N. 22 45  9.5 | +14.64 | 15 47.63 | 68.70 | 1 28.86 | 0.455 |
| Tues. | 10 | 5 12 57.61 | 10.348 | 23  0 55.9 | 11.63 | 15 47.30 | 68.81 | 0 54.76 | 0.490 |
| Wed. | 11 | 5 17  6.09 | 10.358 | 23  5 22.9 | 10.62 | 15 47.20 | 68.84 | 0 42.87 | 0.500 |
| Frid. | 13 | 5 25 23.73 | 10.376 | 23 13  3.8 | 8.58 | 15 47.00 | 68.90 | 0 18.42 | 0.518 |
| Sat. | 14 | 5 29 32.85 | 10.383 | 23 16 17.4 | 7.55 | 15 46.91 | 68.92 | 0  5.89 | 0.525 |
| Frid. | 20 | 5 54 30.05 | 10.402 | 23 27  0.3 | 1.36 | 15 46.48 | 68.98 | 1 11.75 | 0.546 |
| Sat. | 21 | 5 58 39.75 | 10.402 | 23 27 20.5 | + 0.32 | 15 46.43 | 68.98 | 1 24.86 | 0.546 |
| Wed. | 25 | 6 15 18.00 | 10.389 | 23 24 33.1 | − 3.78 | 15 46.27 | 68.94 | 2 16.72 | 0.532 |
| Thur. | 26 | 6 19 27.29 | 10.383 | 23 22 49.5 | 4.81 | 15 46.24 | 68.93 | 2 29.42 | 0.526 |
| Frid. | 27 | 6 23 36.42 | 10.376 | N. 23 20 41.3 | − 5.84 | 15 46.22 | 68.91 | 2 41.97 | 0.519 |
| | | | | JULY. | | | | | |
| Frid. | 11 | 7 21 16.72 | 10.197 | N. 22  8 29.2 | −19.76 | 15 46.30 | 68.30 | 5 10.04 | 0.339 |
| Sat. | 12 | 7 25 21.24 | 10.179 | 22  0 23.2 | 20.71 | 15 46.33 | 68.24 | 5 17.99 | 0.321 |
| Tues. | 22 | 8  5 39.82 | 9.964 | 20 19  8.9 | 29.72 | 15 46.94 | 67.51 | 6 10.85 | 0.108 |
| Wed. | 23 | 8  9 38.68 | 9.939 | 20  7  5.2 | 30.57 | 15 47.03 | 67.43 | 6 13.15 | 0.083 |
| Thur. | 24 | 8 13 36.94 | 9.914 | N. 19 54 41.3 | −31.41 | 15 47.13 | 67.35 | 6 14.84 | 0.059 |
| | | | | SEPTEMBER. | | | | To be subtracted from Apparent Time. | |
| Wed. | 10 | 11 13 33.93 | 8.993 | N.  4 59 24.2 | −56.90 | 15 55.81 | 64.12 | 3  1.29 | 0.862 |
| Thur. | 11 | 11 17  9.68 | 8.988 | N.  4 36 36.2 | −57.10 | 15 56.06 | 64.10 | 3 22.03 | 0.867 |
| | | | | DECEMBER. | | | | | |
| Mon. | 22 | 18  1 24.12 | 11.108 | S. 23 27 17.3 | + 0.37 | 16 18.13 | 71.30 | 1 16.61 | 1.248 |
| Tues. | 23 | 18  5 50.72 | 11.107 | S. 23 26 54.3 | + 1.55 | 16 18.18 | 71.30 | 0 46.64 | 1.246 |

NOTE.—Mean Time of the Semidiameter passing may be found by subtracting 0ˢ.18 from the Sidereal Time.
    + prefixed to the hourly change of declination indicates that north declinations are increasing and south declinations are decreasing; − indicates that north declinations are decreasing and south declinations increasing.

[Extracts: Page II.]

## AT GREENWICH MEAN NOON.

| Day of the Week. | Day of the Month. | THE SUN'S | | | | Equation of Time, *to be subtracted from added to Mean Time.* | Diff. for 1 hour. | Sidereal Time or Right Ascension of *Mean* Sun. |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | *Apparent* Right Ascension. | Diff. for 1 hour. | *Apparent* Declination. | Diff. for 1 hour. | | | |
| | | *h. m. s.* | *s.* | *° ′ ″* | *″* | *m. s.* | *s.* | *h. m. s.* |
| | | | | **JANUARY.** | | | | |
| Frid. | 10 | 19 26 16.08 | 10.866 | S. 21 58 32.0 | + 22.35 | 7 43.42 | 1.010 | 19 18 32.66 |
| Sat. | 11 | 19 30 36.59 | 10.842 | 21 49 22.7 | 23.41 | 8 7.37 | 0.986 | 19 22 29.22 |
| Mon. | 20 | 20 9 12.84 | 10.593 | 20 8 26.6 | 32.48 | 11 14.60 | 0.738 | 19 57 58.24 |
| Tues. | 21 | 20 13 26.71 | 10.562 | S. 19 55 15.6 | + 33.42 | 11 31.91 | 0.706 | 20 1 54.80 |
| | | | | **APRIL.** | | | | |
| Tues. | 1 | 0 41 54.27 | 9.098 | N. 4 30 39.4 | + 57.86 | 4 0.65 | 0.758 | 0 37 53.62 |
| Wed. | 2 | 0 45 32.68 | 9.102 | 4 53 45.6 | 57.65 | 3 42.50 | 0.754 | 0 41 50.16 |
| Tues. | 8 | 1 7 26.22 | 9.146 | 7 10 20.3 | 56.08 | 1 56.74 | 0.709 | 1 5 29.48 |
| Wed. | 9 | 1 11 5.87 | 9.157 | 7 32 42.8 | 55.77 | 1 39.83 | 0.698 | 1 9 26.04 |
| Tues. | 15 | 1 33 9.91 | 9.236 | 9 44 7.4 | 53.65 | 0 4.54 | 0.620 | 1 33 5.37 |
| Wed. | 16 | 1 36 51.77 | 9.252 | 10 5 30.1 | 53.24 | 0 10.15 | 0.604 | 1 37 1.92 |
| Thur. | 17 | 1 40 34.02 | 9.269 | 10 26 42.8 | 52.81 | 0 24.46 | 0.587 | 1 40 58.48 |
| *Sun.* | 20 | 1 51 43.19 | 9.321 | 11 29 18.1 | 51.46 | 1 4.94 | 0.536 | 1 52 48.13 |
| Mon. | 21 | 1 55 27.08 | 9.338 | 11 49 47.6 | 50.98 | 1 17.61 | 0.518 | 1 56 44.69 |
| Tues. | 22 | 1 59 11.41 | 9.356 | 12 10 5.4 | 50.48 | 1 29.83 | 0.500 | 2 0 41.24 |
| Wed. | 23 | 2 2 56.19 | 9.375 | 12 30 11.2 | 49.97 | 1 41.61 | 0.481 | 2 4 37.80 |
| Thur. | 24 | 2 6 41.42 | 9.394 | 12 50 4.7 | 49.46 | 1 52.93 | 0.462 | 2 8 34.35 |
| Frid. | 25 | 2 10 27.11 | 9.414 | 13 9 45.4 | 48.92 | 2 3.80 | 0.442 | 2 12 30.91 |
| Tues. | 29 | 2 25 34.67 | 9.494 | 14 26 14.5 | 46.65 | 2 42.46 | 0.361 | 2 28 17.13 |
| Wed. | 30 | 2 29 22.79 | 9.515 | N. 14 44 46.7 | + 46.04 | 2 50.89 | 0.340 | 2 32 13.68 |
| | | | | **MAY.** | | | | |
| Frid. | 9 | 3 4 0.01 | 9.723 | N. 17 20 3.5 | + 40.06 | 3 42.68 | 0.134 | 3 7 42.69 |
| Sat. | 10 | 3 7 53.65 | 9.747 | 17 35 56.3 | 39.33 | 3 45.59 | 0.109 | 3 11 39.24 |
| *Sun.* | 11 | 3 11 47.89 | 9.771 | 17 51 31.6 | 38.59 | 3 47.91 | 0.084 | 3 15 35.80 |
| Mon. | 12 | 3 15 42.71 | 9.796 | 18 6 48.9 | 37.84 | 3 49.64 | 0.060 | 3 19 32.35 |
| Frid. | 16 | 3 31 27.90 | 9.895 | 19 4 53.8 | 34.72 | 3 50.68 | 0.039 | 3 35 18.58 |
| Sat. | 17 | 3 35 25.67 | 9.919 | 19 18 37.6 | 33.91 | 3 49.47 | 0.062 | 3 39 15.14 |
| *Sun.* | 18 | 3 39 24.01 | 9.942 | 19 32 1.8 | 33.09 | 3 47.68 | 0.086 | 3 43 11.69 |
| Wed. | 28 | 4 19 36.81 | 10.155 | 21 27 5.9 | 24.28 | 3 0.46 | 0.297 | 4 22 37.27 |
| Thur. | 29 | 4 23 40.75 | 10.173 | 21 36 37.4 | 23.34 | 2 53.08 | 0.315 | 4 26 33.83 |
| Frid. | 30 | 4 27 45.12 | 10.190 | 21 45 46.5 | 22.40 | 2 45.26 | 0.334 | 4 30 30.38 |
| Sat. | 31 | 4 31 49.91 | 10.207 | N. 21 54 33.0 | + 21.45 | 2 37.03 | 0.351 | 4 34 26.94 |

| | | | | **JUNE.** | | *To be added to subtracted from Mean Time.* | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sat. | 7 | 5 0 34.00 | 10.311 | N. 22 45 9.9 | + 14.64 | 1 28.85 | 0.455 | 5 2 2.85 |
| *Sun.* | 8 | 5 4 41.64 | 10.324 | 22 50 49.3 | 13.64 | 1 17.77 | 0.467 | 5 5 59.41 |
| Wed. | 11 | 5 17 6.22 | 10.357 | 23 5 23.0 | 10.62 | 0 42.86 | 0.500 | 5 17 49.08 |
| Sat. | 14 | 5 29 32.87 | 10.382 | 23 16 17.4 | 7.55 | 0 5.89 | 0.525 | 5 29 38.76 |
| *Sun.* | 15 | 5 33 42.11 | 10.388 | 23 19 6.4 | + 6.52 | 0 6.80 | 0.532 | 5 33 35.31 |
| Wed. | 25 | 6 15 17.60 | 10.388 | 23 24 33.2 | − 3.78 | 2 16.70 | 0.532 | 6 13 0.90 |
| Thur. | 26 | 6 19 26.86 | 10.382 | 23 22 49.7 | 4.81 | 2 29.40 | 0.526 | 6 16 57.46 |
| Frid. | 27 | 6 23 35.96 | 10.375 | N. 23 20 41.6 | − 5.84 | 2 41.95 | 0.519 | 6 20 54.01 |

NOTE.—The Semidiameter for Mean Noon may be assumed the same as that for Apparent Noon.
+ prefixed to the hourly change of declination indicates that north declinations are increasing and south declinations are decreasing; — indicates that north declinations are decreasing and south declinations increasing.

Diff. for 1 hour.
+ 9ˢ.8565.

[Extracts: Page II.]

## AT GREENWICH MEAN NOON—Continued.

| Day of the Week. | Day of the Month. | THE SUN'S | | | | Equation of Time, *to be subtracted from Mean Time.* | Diff. for 1 hour. | Sidereal Time or Right Ascension of Mean Sun. |
|---|---|---|---|---|---|---|---|---|
| | | *Apparent Right Ascension.* | Diff. for 1 hour. | *Apparent Declination.* | Diff. for 1 hour. | | | |
| | | h. m. s. | s. | ° ′ ″ | ″ | m. s. | s. | h. m. s. |
| | | | | | | | | |
| **AUGUST.** | | | | | | | | |
| | | | | | | | | |
| Tues. | 5 | 9 0 27.45 | 9.610 | N. 17 1 29.2 | − 40.52 | 5 47.69 | 0.246 | 8 54 39.76 |
| Wed. | 6 | 9 4 17.82 | 9.586 | N. 16 45 8.6 | − 41.20 | 5 41.51 | 0.270 | 8 58 36.31 |
| | | | | | | *To be added to Mean Time.* | | |
| **SEPTEMBER.** | | | | | | | | |
| | | | | | | | | |
| Wed. | 10 | 11 13 34.39 | 8.995 | N. 4 59 21.3 | − 56.91 | 3 1.33 | 0.862 | 11 16 35.72 |
| Thur. | 11 | 11 17 10.19. | 8.990 | N. 4 36 32.9 | − 57.12 | 3 22.07 | 0.867 | 11 20 32.26 |
| | | | | | | | | |
| **OCTOBER.** | | | | | | | | |
| | | | | | | | | |
| Wed. | 15 | 13 20 28.07 | 9.309 | S. 8 29 16.2 | − 55.65 | 14 7.02 | 0.548 | 13 34 35.08 |
| Thur. | 16 | 13 24 11.75 | 9.333 | 8 51 28.1 | 55.34 | 14 19.89 | 0.524 | 13 38 31.64 |
| Frid. | 17 | 13 27 56.01 | 9.357 | 9 13 32.4 | 55.02 | 14 32.18 | 0.500 | 13 42 28.19 |
| Tues. | 28 | 14 9 44.78 | 9.662 | 13 6 ·2.6 | 50.34 | 16 5.51 | 0.195 | 14 25 50.29 |
| Wed. | 29 | 14 13 37.03 | 9.693 | S. 13 26 4.6 | − 49.82 | 16 9.82 | 0.164 | 14 29 46.84 |
| | | | | | | | | |
| **NOVEMBER.** | | | | | | | | |
| | | | | | | | | |
| Wed. | 12 | 15 9 14.01 | 10.180 | S. 17 41 18.4 | − 40.77 | 15 44.60 | 0.323 | 15 24 58.61 |
| Thur. | 13 | 15 13 18.76 | 10.216 | S. 17 57 27.6 | − 39.99 | 15 36.41 | 0.359 | 15 28 55.17 |
| | | | | | | | | |
| **DECEMBER.** | | | | | | | | |
| | | | | | | | | |
| Wed. | 3 | 16 37 40.65 | 10.844 | S. 22 6 24.6 | − 21.30 | 10 5.66 | 0.987 | 16 47 46.31 |
| Thur. | 4 | 16 42 1.22 | 10.869 | 22 14 43.0 | 20.23 | 9 41.65 | 1.013 | 16 51 42.87 |
| Mon. | 8 | 16 59 29.19 | 10.960 | 22 43 35.6 | 15.83 | 7 59.91 | 1.104 | 17 7 29.10 |
| Tues. | 9 | 17 3 52.48 | 10.979 | 22 49 42.3 | 14.71 | 7 33.18 | 1.123 | 17 11 25.66 |
| Wed. | 10 | 17 8 16.23 | 10.998 | 22 55 21.9 | 13.58 | 7 5.99 | 1.142 | 17 15 22.22 |
| Thur. | 11 | 17 12 40.41 | 11.015 | 23 0 34.3 | − 12.45 | 6 38.37 | 1.159 | 17 19 18.78 |
| Mon. | 22 | 18 1 24.34 | 11.104 | 23 27 17.3 | + 0.37 | 1 16.58 | 1.248 | 18 2 40.92 |
| Tues. | 23 | 18 5 50.85 | 11.103 | 23 26 54.3 | 1.55 | 0 46.63 | 1.246 | 18 6 37.48 |
| Wed. | 24 | 18 10 17.33 | 11.101 | S. 23 26 2.9 | + 2.73 | 0 16.71 | 1.244 | 18 10 34.03 |

NOTE.—The Semidiameter for Mean Noon may be assumed the same as that for Apparent Noon.
+ prefixed to the hourly change of declination indicates that north declinations are increasing and south declinations are decreasing; − indicates that north declinations are decreasing and south declinations increasing.

Diff. for 1 hour.
+9ˢ.8565

[Extracts: Page III.]

## AT GREENWICH MEAN NOON.

| Day of the Month. | Day of the Year. | The Sun's True LONGITUDE. λ (° ′ ″) | λ′ (′ ″) | Diff. for 1 hour. (″) | LATITUDE. (″) | Logarithm of the Radius Vector of the Earth. | Diff. for 1 hour. | Mean time of Sidereal 0h. (h. m. s.) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | APRIL. | | |
| 21 | 111 | 30 60 16.5 | 59 47.4 | 146.27 | +0.52 | 0.0023923 | +48.8 | 21 59 38.53 |
| 22 | 112 | 31 58 46.1 | 58 16.9 | 146.19 | +0.52 | 0.0025087 | +48.3 | 21 55 42.62 |

[Extracts: Page IV.]

## GREENWICH MEAN TIME.

| Day of the Month. | THE MOON'S SEMIDIAMETER. Noon. (′ ″) | Midnight. (′ ″) | HORIZONTAL PARALLAX. Noon. (′ ″) | Diff. for 1 hour. (″) | Midnight. (′ ″) | Diff. for 1 hour. (″) | MERIDIAN PASSAGE. (h. m.) | Diff. for 1 hour. (m.) | AGE. Noon. (d.) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | APRIL. | | | | |
| 16 | 15  4.7 | 15  0.6 | 55 13.6 | −1.34 | 54 58.5 | −1.19 | 21  3.8 | 1.71 | 24.6 |
| 17 | 14 57.0 | 14 53.8 | 54 45.1 | 1.04 | 54 33.5 | 0.90 | 21 44.3 | 1.67 | 25.6 |
| 18 | 14 51.1 | 14 48.9 | 54 23.5 | 0.76 | 54 15.2 | 0.63 | 22 24.6 | 1.68 | 26.6 |
| 19 | 14 47.0 | 14 45.6 | 54  8.4 | 0.50 | 54  3.1 | 0.38 | 23  5.4 | 1.73 | 27.6 |
| 20 | 14 44.5 | 14 43.7 | 53 59.1 | 0.27 | 53 56.5 | −0.16 | 23 47.7 | 1.81 | 28.6 |
| 21 | 14 43.4 | 14 43.4 | 53 55.3 | −0.05 | 53 55.3 | +0.06 | ☽ | | 29.6 |
| 22 | 14 43.8 | 14 44.6 | 53 56.7 | +0.17 | 53 59.4 | 0.29 | 0 32.2 | 1.90 | 0.9 |
| 23 | 14 45.7 | 14 47.2 | 54  3.6 | 0.41 | 54  9.3 | 0.54 | 1 19.0 | 2.01 | 1.9 |
| 24 | 14 49.2 | 14 51.6 | 54 16.5 | 0.67 | 54 25.3 | 0.80 | 2  8.2 | 2.10 | 2.9 |
| 25 | 14 54.5 | 14 57.8 | 54 35.8 | 0.94 | 54 48.0 | 1.09 | 2 59.3 | 2.15 | 3.9 |
| 26 | 15  1.6 | 15  5.9 | 55  2.1 | +1.24 | 55 17.9 | +1.39 | 3 51.2 | 2.16 | 4.9 |
| | | | | | MAY. | | | | |
| 6 | 16 44.6 | 16 42.1 | 61 20.1 | −0.53 | 61 11.3 | −0.93 | 12 36.6 | 2.66 | 14.9 |
| 7 | 16 38.5 | 16 33.7 | 60 57.8 | −1.29 | 60 40.2 | −1.62 | 13 41.2 | 2.69 | 15.9 |
| 28 | 15 47.0 | 15 53.2 | 57 48.8 | +1.86 | 58 11.4 | +1.90 | 5 55.3 | 1.95 | 7.3 |
| 29 | 15 59.4 | 16  5.6 | 58 34.3 | +1.90 | 58 57.1 | +1.88 | 6 42.5 | 1.98 | 8.3 |
| | | | | | JUNE. | | | | |
| 25 | 15 49.8 | 15 54.3 | 57 59.1 | 1.37 | 58 15.5 | 1.36 | 4 40.1 | 1.94 | 5.7 |
| 26 | 15 58.7 | 16  3.0 | 58 31.7 | 1.34 | 58 47.6 | 1.30 | 5 27.0 | 1.98 | 6.7 |
| 27 | 16  7.2 | 16 11.1 | 59  3.0 | 1.25 | 59 17.5 | 1.17 | 6 15.6 | 2.08 | 7.7 |

[Extracts: Pages V–XII.]

## GREENWICH MEAN TIME.

### THE MOON'S RIGHT ASCENSION AND DECLINATION.

| Hour. | Right Ascension. | Diff. for 1 m. | Declination. | Diff. for 1 m. | Hour. | Right Ascension. | Diff. for 1 m. | Declination. | Diff. for 1 m. |
|---|---|---|---|---|---|---|---|---|---|
| | h. m. s. | s. | ° ′ ″ | ″ | | h. m. s. | s. | ° ′ ″ | ″ |
| | THURSDAY, APRIL 10. | | | | | WEDNESDAY, MAY 28. | | | |
| 17 | 17 18 38.57 | 2.6448 | S. 26 19 38.3 | − 0.138 | 6 | 10 19 4.23 | 2.0591 | N. 7 4 18.5 | −14.411 |
| 18 | 17 21 17.16 | 2.6414 | 26 19 41.1 | + 0.044 | 7 | 10 21 7.78 | 2.0592 | 6 49 52.4 | 14.459 |
| 19 | 17 23 55.54 | 2.6379 | S. 26 19 33.0 | + 0.225 | 8 | 10 23 11.34 | 2.0593 | N. 6 35 23.4 | −14.507 |
| | WEDNESDAY, APRIL 16. | | | | | THURSDAY, JUNE 26. | | | |
| 4 | 22 12 47.08 | 1.8718 | S. 8 12 37.4 | +13.010 | 2 | 11 37 41.96 | 2.0743 | S. 2 35 36.4 | −15.135 |
| 5 | 22 14 39.29 | 1.8685 | 7 59 36.1 | 13.032 | 3 | 11 39 46.49 | 2.0767 | 2 50 44.4 | 15.133 |
| 6 | 22 16 31.30 | 1.8653 | S. 7 46 33.5 | +13.054 | 11 | 11 56 28.42 | 2.0989 | S. 4 51 36.5 | −15.069 |
| | FRIDAY, APRIL 25. | | | | | MONDAY, DECEMBER 8. | | | |
| 16 | 5 41 33.19 | 2.2558 | N. 26 5 43.8 | − 1.272 | 2 | 12 23 13.52 | 2.1615 | S. 8 9 24.4 | 14.354 |
| 17 | 5 43 48.55 | 2.2562 | 26 4 23.5 | 1.405 | 3 | 12 25 23.37 | 2.1668 | 8 23 44.9 | 14.328 |
| 18 | 5 46 3.93 | 2.2566 | N. 26 2 55.2 | − 1.537 | 4 | 12 27 33.54 | 2.1722 | S. 8 38 3.8 | 14.302 |
| | TUESDAY, APRIL 29. | | | | | | | | |
| 11 | 9 2 56.23 | 2.1384 | N. 15 27 3.6 | −12.135 | | | | | |
| 12 | 9 5 4.49 | 2.1369 | 15 14 52.7 | 12.227 | | | | | |
| 13 | 9 7 12.66 | 2.1356 | N. 15 2 36.3 | −12.318 | | | | | |

[Extracts: Pages relating to Planets.]

## GREENWICH MEAN TIME.

### JUPITER.

#### April.

| Day of Month | Apparent Right Ascension. Noon. | Var. of R. A. for 1 Hour. Noon. | Apparent Declination. Noon. | Var. of Dec. for 1 Hour. Noon. | Meridian Passage. |
|---|---|---|---|---|---|
| | h. m. s. | s. | ° ′ ″ | ″ | h. m. |
| 15 | 22 25 51.70 | +1.834 | −10 44 29.6 | +10.10 | 20 50.0 |
| 16 | 22 26 35.54 | 1.819 | 10 40 28.0 | 10.03 | 20 46.8 |
| 17 | 22 27 19.02 | 1.804 | 10 36 28.1 | 9.96 | 20 43.6 |
| 18 | 22 28 2.14 | +1.789 | −10 32 30.0 | +9.89 | 20 40.3 |

| Day of the Month. | 1st. | 11th. | 21st. | 31st. |
|---|---|---|---|---|
| | ″ | ″ | ″ | ″ |
| Polar Semidiameter | 16.4 | 16.7 | 17.1 | 17.5 |
| Horizontal Parallax | 1.5 | 1.6 | 1.6 | 1.6 |

### VENUS.

#### April.

| Day of Month | Apparent Right Ascension. Noon. | Var. of R. A. for 1 Hour. Noon. | Apparent Declination. Noon. | Var. of Dec. for 1 Hour. Noon. | Meridian Passage. |
|---|---|---|---|---|---|
| | h. m. s. | s. | ° ′ ″ | ″ | h. m. |
| 24 | 4 19 14.43 | +12.686 | +22 40 33.2 | +37.08 | 2 10.7 |
| 25 | 4 24 19.28 | 12.718 | 22 55 4.9 | 35.55 | 2 11.9 |
| 26 | 4 29 24.88 | +12.748 | +23 8 59.5 | +34.00 | 2 13.0 |

| Day of the month. | 1st. | 6th. | 11th. | 16th. | 21st. | 26th. |
|---|---|---|---|---|---|---|
| | ″ | ″ | ″ | ″ | ″ | ″ |
| Semidiameter | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.6 |
| Hor. Parallax | 6.2 | 6.3 | 6.4 | 6.5 | 6.7 | 6.8 |

#### September.

| Day of Month | Apparent Right Ascension. Noon. | Var. of R. A. for 1 Hour. Noon. | Apparent Declination. Noon. | Var. of Dec. for 1 Hour. Noon. | Meridian Passage. |
|---|---|---|---|---|---|
| | h. m. s. | s. | ° ′ ″ | ″ | h. m. |
| 16 | 22 32 5.11 | −1.134 | −10 44 20.5 | −6.58 | 10 49.8 |
| 17 | 22 31 38.03 | −1.120 | −10 46 57.2 | −6.47 | 10 45.5 |

| Day of Month. | 1st. | 11th. | 21st. | 31st. |
|---|---|---|---|---|
| | ″ | ″ | ″ | ″ |
| Polar Semidiameter | 23.6 | 23.5 | 23.2 | 22.8 |
| Horizontal Parallax | 2.2 | 2.2 | 2.2 | 2.2 |

### MARS.

#### March.

| Day of Month | Apparent Right Ascension. Noon. | Var. of R. A. for 1 Hour. Noon. | Apparent Declination. Noon. | Var. of Dec. for 1 Hour. Noon. | Meridian Passage. |
|---|---|---|---|---|---|
| | h. m. s. | s. | ° ′ ″ | ″ | h. m. |
| 17 | 20 5 56.83 | +7.690 | −21 13 58.1 | +20.48 | 20 26.4 |
| 18 | 20 9 1.27 | 7.680 | 21 5 40.4 | 20.98 | 20 25.6 |
| 19 | 20 12 5.45 | +7.669 | −20 57 10.7 | +21.48 | 20 24.7 |

NOTE.—North declinations are marked +, south declinations −.
+ prefixed to the hourly change of declination, indicates that north declinations are increasing and south declinations are decreasing; − indicates that north declinations are decreasing and south declinations increasing.

[Extracts: Pages relating to Fixed Stars.]

## FIXED STARS.

### MEAN PLACES FOR 1879.0.    (Jan. 0 + d.016, Washington.)

| Star's Name. | Magnitude. | Right Ascension. | An. Variation. | Declination. | An. Variation. |
|---|---|---|---|---|---|
| | | h. m. s. | s. | ° ′ ″ | ″ |
| α Ursæ Min. (*Polaris*)* ......... | 2 | 1 14 24.861 | +21.485 | +88 39 49.92 | +19.00 |
| α Eridani (*Achernar*) ........... | 1 | 1 33 12.133 | + 2.233 | −57 51 5.79 | +18.40 |
| α Tauri (*Aldebaran*) ........... | 1 | 4 28 58.716 | + 3.437 | +16 15 53.35 | + 7.59 |
| μ Geminorum ................... | 3 | 6 15 38.457 | + 3.633 | +22 34 26.94 | − 1.48 |
| α Canis Maj. (*Sirius*) ......... | 1 | 6 39 48.935 | + 2.645 | −16 33 4.30 | − 4.68 |
| α Virginis (*Spica*) ........... | 1 | 13 18 49.216 | + 3.154 | −10 31 44.21 | −18.90 |
| α Bootis (*Arcturus*) ........... | 1 | 14 10 8.551 | + 2.735 | +19 48 48.59 | −18.87 |
| α Scorpii (*Antares*) ........... | 1.2 | 16 21 59.432 | + 3.670 | −26 9 41.94 | − 8.34 |

* Circumpolar Star.

### APPARENT PLACES FOR THE UPPER TRANSIT AT WASHINGTON.

| α Ursæ Minoris. (*Polaris.*) | | | α Eridani. (*Achernar.*) | | | α Tauri. (*Aldebaran.*) | | |
|---|---|---|---|---|---|---|---|---|
| Mean Solar Date. | Right Ascension. | Declination *North.* | Mean Solar Date. | Right Ascension. | Declination *South.* | Mean Solar Date. | Right Ascension. | Declination *North.* |
| | h. m. 1 13 | ° ′ +88 39 | | h. m. 1 33 | ° ′ −57 50 | | h. m. 4 28 | ° ′ +16 15 |
| | s. | ″ | | s. | ″ | | s. | ″ |
| June 10.8 | 63.54 | 47.1 | July 27.7 | 14.91 +.47 | 28.6 +0.5 | Apr. 9.1 | 59.66 −.10 | 58.7 −0.2 |
| 11.8 | 64.35 | 47.0 | Aug. 6.7 | 15.37 +.45 | 28.3 0.0 | 19.1 | 59.57 .07 | 58.6 −0.1 |
| 12.8 | 65.21 | 46.9 | | | | 29.1 | 59.52 −.02 | 58.5 0.0 |

| α Canis Majoris. (*Sirius.*) | | | α Virginis. (*Spica.*) | | | α Bootis. (*Arcturus.*) | | |
|---|---|---|---|---|---|---|---|---|
| Mean Solar Date. | Right Ascension. | Declination *South.* | Mean Solar Date. | Right Ascension. | Declination *South.* | Mean Solar Date. | Right Ascension. | Declination *North.* |
| | h. m. 6 39 | ° ′ −16 32 | | h. m. 13 18 | ° ′ −10 31 | | h. m. 14 10 | ° ′ +19 48 |
| | s. | ″ | | s. | ″ | | s. | ″ |
| (Dec. 30.5) | 51.06 +.10 | 63.7 −2.5 | Apr. 29.5 | 52.28 +.02 | 64.6 −0.1 | May 9.4 | 11.71 +.02 | 32.1 +1.6 |
| Jan. 9.5 | 51.14 +.05 | 66.1 −2.3 | May 9.4 | 52.29 .00 | 64.7 0.0 | 19.4 | 11.71 −.01 | 33.7 +1.6 |
| Apr. 9.2 | 50.09 −.18 | 76.2 +0.3 | 19.4 | 52.28 −.03 | 64.6 +0.1 | | | |
| 19.2 | 49.92 .16 | 75.8 0.6 | 29.4 | 52.24 .04 | 64.4 0.3 | | | |
| 29.2 | 49.77 .13 | 75.0 0.9 | June 8.3 | 52.19 −.60 | 64.1 +0.4 | | | |
| May 9.2 | 49.65 −.10 | 74.0 +1.1 | | | | | | |

| α Scorpii. (*Antares.*) | | |
|---|---|---|
| Mean Solar Date. | Right Ascension. | Declination *South.* |
| | h. m. 16 21 | ° ′ −26 9 |
| | s. | ″ |
| May 9.5 | 63.11 +.19 | 53.8 −0.5 |
| 19.5 | 63.28 .16 | 54.3 0.4 |
| 29.5 | 63.43 .12 | 54.7 0.4 |
| June 8.5 | 63.53 .09 | 55.0 0.3 |
| 18.4 | 63.60 +.05 | 55.3 −0.3 |
| July 28.3 | 63.49 −.10 | 56.0 0.0 |
| Aug. 7.3 | 63.38 .13 | 55.9 +0.1 |
| 17.3 | 63.24 −.15 | 55.8 +0.2 |

# APPENDIX II.

## A COLLECTION OF FORMS FOR WORKING DEAD RECKONING AND VARI- OUS ASTRONOMICAL SIGHTS, WITH NOTES EXPLAINING THEIR APPLICATION UNDER ALL CIRCUMSTANCES.

(The figures in parenthesis refer to the Notes following these forms.)

**FORM FOR DAY'S WORK, DEAD RECKONING.**

| Time. | Compass Course. | Var. | Dev. | Lee-way. | Total error. | True Course. | Patent log. | Dist. | N. | S. | E. | W. | Diff.(1) Long. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

|  | Latitude. | | Longitude. | |
| --- | --- | --- | --- | --- |
|  | ° ′ | | ° ′ | |
| Left at departure (or noon) | ...... | (2) N. or S. | ...... | (2) E. or W. |
| Run to...... | ...... | N. or S. | ...... | E. or W. |
| By D. R. at...... | ...... | N. or S. | ...... | E. or W. |
| Run to...... | ...... | N. or S. | ...... | E. or W. |
| By D. R. at...... | ...... | N. or S. | ...... | E. or W. |

**FORM FOR TIME SIGHT OF SUN'S LOWER LIMB (SUMNER LINE).**

|  | $h.\ m.\ s.$ | |  | $°\ ′\ ′′$ |  |  | $°\ ′\ ′′$ |  |  | $m.\ s.$ |
|---|---|---|---|---|---|---|---|---|---|---|
| W. T. | .......... | | Obs. alt. ☉ | .......... | | (5) Dec. | .......... N. or S. | | (5) Eq. t. | .......... |
| C–W | + .......... | | Corr. | ± .......... | |  | $′′$ | |  | $s.$ |
| Chro. t. | .......... | | $h$ | .......... | | H. D. | ± .......... | | H. D. | ± .......... |
| C. C. | ± .......... | |  | $′\ ′′$ | |  | $h.$ | |  | $h.$ |
| (11) G. M. T. | .......... | | (3) S. D. | + .......... | | G. M. T. | .......... | | G. M. T. | .......... |
| (7) Eq. t. | ± .......... | | (4) I. C. | + .......... | |  | $′\ ′′$ | |  | $s.$ |
| G. A. T. | .......... | |  | + .......... | | Corr. | ± .......... | | Corr. | ± .......... |
|  |  | |  | $′\ ′′$ | |  | $°\ ′\ ′′$ | |  | $m.\ s.$ |
|  |  | | dip | – .....,..... | | Dec. | .......... N. or S. | | Eq. t. | .......... |
|  |  | | p. & r. | – .......... | |  | $°\ ′\ ′′$ | |  |  |
|  |  | |  | .......... | | (6) $p$ | .......... | |  |  |
|  |  | |  | $′\ ′′$ | |  |  | |  |  |
|  |  | | Corr. | ± .......... | |  |  | |  |  |

|  | $°\ ′\ ′′$ |  |  |  | $°\ ′\ ′′$ |  |  |  |
|---|---|---|---|---|---|---|---|---|
| $h$ | .......... |  |  | $l$ |  |  |  |  |
| $L_1$ | .......... | sec | .......... | (9) $L_2$ | .......... | sec | .......... |
| $p$ | .......... | cosec | .......... |  |  | cosec | .......... |
| 2 ).......... |  |  |  |  |  |  |  |
| $s_1$ | .......... | cos | .......... | (10) $s_2$ | .......... | cos | .... ..... |
| $s_1–h$ | .......... | sin | .......... | $s_2–h$ | .......... | sin | .......... |
|  | $h.\ m.\ s.$ |  | 2 ).......... |  | $h.\ m.\ s.$ |  | 2 ).......... |
| G. A. T. | .......... |  |  | G. A. T. | .......... |  |  |
| L. A. T.$_1$ | .......... | sin ¼ $t_1$ | .......... | L. A. T.$_2$ | .......... | sin ¼ $t_2$ | .......... |

(8) Long.$_1$ { $h.\ m.\ s.$ / ° ′ ′′ / .......... } E. or W.                Long.$_2$ { $h.\ m.\ s.$ / ° ′ ′′ / .......... } E. or W.

## FORM FOR TIME SIGHT OF A STAR (SUMNER LINE).

|  | h. m. s. |  | o ′ ″ |  | h. m. s. |
|---|---|---|---|---|---|
| W. T. | ................ | Obs. alt. ✳ | ................ | R. A. | ............... |
| C−W | + ............... | Corr. | ± ................ |  |  |
|  |  |  |  |  | o ′ ″ |
| Chro. t. | ................ | h | ................ | Dec. | ................ N. or S. |
| C. C. | ± ............... |  | ′ ″ |  |  |
|  |  |  |  |  | o ′ ″ |
| (11) G. M. T. | ................ | (4) I. C. | + ............... | (6) p | ............... |
| R. A. M. S. | + ............... |  | ′ ″ |  |  |
| Red. (Tab. 9) | + ............... | dip | − ............... |  |  |
| G. S. T. | ................ | ref. | − ............... |  |  |
| R. A. ✳ | ................ |  | − ............... |  |  |
| (12) H. A. from Gr. | ................ E. or W. |  | ′ ″ |  |  |
|  |  | Corr. | ± ............... |  |  |

|  | o ′ ″ |  |  |  | o ′ ″ |  |  |
|---|---|---|---|---|---|---|---|
| h | ................ |  |  |  | ............ |  |  |
| L₁ | ................ | sec | ............ | (9) L₂ | ............ | sec | ............ |
| p | ................ | cosec | ............ |  |  | cosec | ............ |
|  | 2) ................ |  |  |  |  |  |  |
| s₁ | ................ | cos | ............ | (10) s₂ | ............ | cos | ............ |
| s₁−h | ................ | sin | ............ | s₂−h | ............ | sin | ............ |
|  | h. m. s. |  | 2) ............ |  | h. m. s. |  | 2) ............ |
| Gr. H. A. | ................ E. or W. |  |  | Gr. H. A. | ............ |  |  |
| (13) H. A.₁ | ................ E. or W. | sin ½ t₁ | ............ | H. A.₂ | ............ | sin ½ t₂ | ............ |

$h = $ ................
$L_1 = $ ................ sec ............ 
$p = $ ................ cosec ............

$(14)$ Long.₁ { h. m. s. ................ / o ′ ″ ................ / ................ } E. or W.

Long.₂ { h. m. s. ................ / o ′ ″ ................ / ................ } E. or W.

## FORM FOR TIME SIGHT OF A PLANET (SUMNER LINE).

|  | h. m. s. |  | o ′ ″ |  | h. m. s. |  | o ′ ″ |
|---|---|---|---|---|---|---|---|
| W. T. | ........ | Obs. alt. ✳ | ........ | R. A. | ........ | Dec. | ........ N. or S. |
| C−W | + ........ | Corr. | ± ........ |  |  |  | ″ |
|  |  |  |  |  | s. |  |  |
| Chro. t. | ........ | h | ........ | H. D. | ± ........ | H. D. | ± ........ |
| C. C. | ± ........ |  | ′ ″ |  | h. |  | h. |
|  |  |  |  | G. M. T. | ........ | G. M. T. | ........ |
| (11) G. M. T. | ........ | (15) par. | + ........ |  |  |  |  |
| R. A. M. S. | + ........ | (4) I. C. | + ........ |  | s. |  | ′ ″ |
| Red. (Tab. 9) | + ........ |  | ———— | Corr. | ± ........ | Corr. | ± ........ |
|  |  |  | + ........ |  |  |  |  |
| G. S. T. | ........ |  |  |  | h. m. s. |  | o ′ ″ |
| R. A. ✳ | ........ |  | ′ ″ | R. A. | ........ | Dec. | ........ N. or S. |
| (12) H. A. from Gr. | ........ E. or W. | dip | − ........ |  |  |  |  |
|  |  | ref. | − ........ |  |  |  | o ′ ″ |
|  |  |  | − ........ |  |  | (6) p | ........ |
|  |  |  | ′ ″ |  |  |  |  |
|  |  | Corr. | ± ........ |  |  |  |  |

For the remainder of the work, by which the hour angles and thence the longitudes are found, employ the method given under "Form for Time Sight of a Star (Sumner Line)."

## FORM FOR TIME SIGHT OF MOON'S LOWER LIMB (SUMNER LINE).

| | h. m. s. | | o ′ ″ | | h. m. s. | | o ′ ″ |
|---|---|---|---|---|---|---|---|
| W. T. | ........ | Obs. alt. ☾ | ........ | (17) R. A. | ........ | (17) Dec. | ........ N. or S. |
| C–W | +........ | | ‾‾‾‾ | | ‾‾‾‾ | | ‾‾‾‾ |
| | ‾‾‾‾ | | ′ ″ | | s. | | ″ |
| Chro. t. | ........ | (18) S. D. | +........ | M. D. | +........ | M. D. | ±........ |
| C. C. | ±........ | Aug. | +........ | | m. | | m. |
| | ‾‾‾‾ | (4) I. C. | +........ | No. min. | ±........ | No. min. | ±........ |
| (11) G. M. T. | ........ | | ‾‾‾‾ | | ‾‾‾‾ | | ‾‾‾‾ |
| R. A. M. S. | +........ | | +........ | | s. | | ′ ″ |
| Red. (Tab. 9) | +........ | | ‾‾‾‾ | Corr. | ±........ | Corr. | ±........ |
| | | | ′ ″ | | ‾‾‾‾ | | ‾‾‾‾ |
| G. S. T. | ........ | dip | –........ | | h. m. s. | | o ′ ″ |
| R. A. ☾ | ........ | | ‾‾‾‾ | R. A. | ........ | Dec. | ........ N. or S. |
| | | | ′ ″ | | | | ‾‾‾‾ |
| (12) H.A. from Gr. | ........ E. or W. | 1st corr. | ±........ | | | (6) p | ........ |
| | | | ‾‾‾‾ | | | | |
| | | | o ′ ″ | | | | |
| | | Approx. alt. | ........ | | | | |
| | | p. & r. (Tab. 24) | +........ | | | | |
| | | | ‾‾‾‾ | | | | |
| | | h | ........ | | | | |

For the remainder of the work, by which the hour angles and thence the longitudes are found, employ the method given under " Form for Time Sight of a Star (Sumner Line)."

## FORM FOR MERIDIAN ALTITUDE OF SUN'S LOWER LIMB.

| | o ′ ″ | | ′ ″ | | o ′ ″ |
|---|---|---|---|---|---|
| Obs. alt. ☉ | .......... | (3) S. D. + | ...... | (19) Dec. | .......... N. or S. |
| Corr. | ± .......... | (4) I. C. + | ...... | | ‾‾‾‾ |
| | ‾‾‾‾ | | ‾‾‾‾ | | ″ |
| h | .......... | + | ...... | H. D. | ± .......... |
| | o ′ ″ | | ‾‾‾‾ | | h. |
| (18) z | .......... N. or S. | | ′ ″ | Long. | ± .......... |
| d | .......... N. or S. | dip – | ...... | | ‾‾‾‾ |
| | ‾‾‾‾ | p. & r. – | ...... | | ′ ″ |
| Lat. | .......... N. or S. | | ‾‾‾‾ | Corr. | ± .......... |
| | | – | ...... | | o ′ ″ |
| | | | ‾‾‾‾ | Dec. | .......... N. or S. |
| | | | ′ ″ | | |
| | | Corr. ± | ...... | | |

## FORM FOR MERIDIAN ALTITUDE OF A STAR.

| | c ′ ″ | | ′ ″ | | o ′ ″ |
|---|---|---|---|---|---|
| Obs. alt. ✶ | .......... | (4) I. C. + | ...... | Dec. | .......... N. or S. |
| Corr. | ± .......... | | ′ ″ | | |
| | ‾‾‾‾ | dip ~ | ...... | | |
| h | .......... | ref. – | ...... | | |
| | | | ‾‾‾‾ | | |
| (18) z | .......... N. or S. | – | ...... | | |
| d | .......... N. or S. | | ′ ″ | | |
| | ‾‾‾‾ | Corr. ± | ...... | | |
| Lat. | .......... N. or S. | | | | |

## FORM FOR MERIDIAN ALTITUDE OF A PLANET.

| | o ′ ″ | | ′ ″ | | h. m. | | o ′ ″ |
|---|---|---|---|---|---|---|---|
| Obs. alt. ✶ | .......... | (15) par. + | ...... | G. M. T., Gr. trans. | ...... | Dec. | ........ N. or S. |
| Corr. | ± .......... | (4) I. C. + | ...... | Corr. for Long. | ± ...... | | ‾‾‾‾ |
| | ‾‾‾‾ | | ‾‾‾‾ | | | | ″ |
| h | .......... | + | ...... | L. M. T., local trans. | ...... | H. D. | ± ........ |
| | ‾‾‾‾ | | ‾‾‾‾ | Long. | ± ...... | | h. |
| | o ′ ″ | | ′ ″ | | ‾‾‾‾ | G. M. T. | ........ |
| (18) z | .......... N. or S. | dip – | ...... | G. M. T., local trans. | ...... | | ‾‾‾‾ |
| d | .......... N. or S. | ref. – | ...... | | | | ′ ″ |
| | ‾‾‾‾ | | ‾‾‾‾ | | | Cor. | ± .......... |
| Lat. | .......... N. or S. | – | ...... | | | | o ′ ″ |
| | | | ′ ″ | | | Dec. | .......... N. or S. |
| | | Corr. ± | ...... | | | | |

## FORM FOR MERIDIAN ALTITUDE OF MOON'S LOWER LIMB.

| | ° ′ ″ | | | ° ′ ″ | | h. m. | | • ′ ″ |
|---|---|---|---|---|---|---|---|---|
| h | .......... | Obs. alt. ☽ | ........ | | G. M. T., Gr. trans. | ...... | (17) Dec. | ........ N. or S. |
| | ° ′ ″ | | | ′ ″ | Corr. for Long.(Tab.11) ± ...... | | | ″ |
| (18) z | .......... N. or S. | (16) S. D. | + ........ | | L. M. T., local trans. | ...... | M. D. | ± ........ |
| d | .......... N. or S. | Aug. | + ........ | | Long. | ± ...... | | m. |
| Lat. | .......... N. or S. | (4) I.C. | + ........ | | | | No. min. | ± ........ |
| | | | | | G. M. T., local trans. | ...... | | ′ ″ |
| | | | + ........ | | | | Corr. | ± ........ |
| | | | | ′ ″ | | | | ° ′ ″ |
| | | dip | − ........ | | | | Dec. | ........ N. or S. |
| | | | | ′ ″ | | | | |
| | | 1st corr | ± ........ | | | | | |
| | | | | ° ′ ″ | | | | |
| | | Approx. Alt. | ........ | | | | | |
| | | p. & r. (Tab.24) + ........ | | | | | | |
| | | h | ........ | | | | | |

## ALTERNATIVE FORM FOR MERIDIAN ALTITUDE OF A BODY. (20)

|  | ± 90° 00′ 00″ | |
|---|---|---|
| (21) Dec. | ± ............. | |
| Corr. | ± ............. | |
| Constant | ± ............. | |
| Obs. alt. | ± ............. | |
| Lat. | ............. N. or S. | |

*Rules for signs.*

Case    I. Lat. & Dec. same name, Lat. greater........... + 90° + Dec. − Corr. − Alt.
Case   II. Lat. & Dec. same name, Dec. greater .......... − 90° + Dec. + Corr. + Alt.
Case III. Lat. and Dec. opposite names.................... + 90° − Dec. − Corr. − Alt.
Case IV. Lower transit .................................... + 90° − Dec. + Corr. + Alt.

## FORM FOR LATITUDE SIGHTS OF SUN'S LOWER LIMB (SUMNER LINE).

| | h. m. s. | | ° ′ ″ | | ° ′ ″ | | m. s. |
|---|---|---|---|---|---|---|---|
| W. T. | ............ | Obs. alt. ☉ | .......... | (5) Dec. | .......... N. or S. | (5) Eq. t. | .......... |
| C−W | ± ............ | Corr. | ± ........ | | ″ | | |
| Chro. t. | ............ | h | .......... | H.D. | ± .......... | H.D. | ± .......... |
| C. C. ± | ............ | | ′ ″ | | h. | | h. |
| (11) G.M.T. | ............ | (3) S. D. | + .......... | G. M. T. | ............ | G. M. T. | ............ |
| (7) Eq. t. ± | ............ | (4) I.C. | + .......... | | ′ ″ | | s. |
| G. A. T. | ............ | | + .......... | Corr. | ± .......... | Corr. | ± .......... |
| Long. 1 ± | ............ | | ′ ″ | | ° ′ ″ | | m. s. |
| L.A.T. 1 | ............ | dip | − .......... | Dec. | .......... N. or S. | Eq. t. | .......... |
| | h. m. s. | p. & r. | − .......... | | | | |
| (22) t 1 { | ............ | | − .......... | | | | |
| | ° ′ ″ | | ′ ″ | | | | |
| | ............ | Corr. | ± .......... | | | | |
| | h. m. s. | | | | | | |
| (23) Long. 2 ± | ............ | | | | | | |
| L.A.T. 2 | ............ | | | | | | |
| | h. m. s. | | | | | | |
| t 2 { | ............ | | | | | | |
| | ° ′ ″ | | | | | | |

#### φ′ φ″ Method.

| | ° ′ ″ | | | |
|---|---|---|---|---|
| t 1 | .......... | sec........ | | |
| d | .......... | tan ....... | cosec ..... | |
| h | .......... | sin........ | | |
| (24) φ 1″ | .......... N. or S. | tan ....... | sin........ | |
| φ 1′ | .......... N. or S. | | cos........ | |
| Lat. 1 | .......... N. or S. | | | |

| | ° ′ ″ | | | |
|---|---|---|---|---|
| t 2 | .......... | sec........ | | |
| d | .......... | tan ....... | cosec ..... | |
| h | .......... | | sin........ | |
| φ 2″ | .......... | tan ....... | sin........ | |
| φ 2′ | .......... | | cos........ | |
| Lat. 2 | .......... N. or S. | | | |

#### Reduction to Meridian.

| | ″ | | | ° ′ ″ |
|---|---|---|---|---|
| (25) a | .......... | | h | .......... |
| | ° ′ ″ | | a t 2² ± | .......... |
| h | .......... | | | ° ′ ″ |
| (26) a t 1² ± | .......... | | H 2 | .......... |
| H 1 | .......... | | z 2 | .......... N. or S. |
| | ° ′ ″ | | d | .......... |
| (18) z 1 | .......... N. or S. | | Lat. 2 | .......... N. or S. |
| d | .......... N. or S. | | | |
| Lat. 1 | .......... N. or S. | | | |

### FORM FOR LATITUDE SIGHTS OF A STAR (SUMNER LINE).

|  | h. m. s. |  |
|---|---|---|
| W. T. | .......... |  |
| C–W | + . ........ |  |
| Chro. t. | .......... |  |
| C. C. | ± .... ..... |  |
| (11) G. M. T. | .......... |  |
| R. A. M. S. | + .......... |  |
| Red.(Tab.9) | + .......... |  |
| G. S. T. | .......... |  |
| R. A.✶ | .......... |  |
| (12) H. A. from Gr. | .......... E. *or* W. |  |
| (27) Long.₁ | .......... E. *or* W. |  |

$t_1$

| h. m. s. | |
|---|---|
| .......... | |
| o ′ ″ | } E. *or* W. |
| .......... | |

|  | h. m. s. |
|---|---|
| (23) Long.₂ | .......... |

$t_2$

| h. m. s. |
|---|
| .......... |
| o ′ ·″ |
| .......... |

|  | o ′ ″ |
|---|---|
| Obs. alt.✶ | .......... |
| Corr. | ± .......... |
| $h$ | .......... |

| | ′ ″ |
|---|---|
| (4) I. C. | + .......... |

| | ′ ″ |
|---|---|
| dip | − .......... |
| ref. | − .......... |

| | − .......... |
|---|---|
| | ′ ″ |

| Corr. | ± .......... |
|---|---|

|  | h. m. s. |  |
|---|---|---|
| R. A. | .......... |  |
| Dec. | .......... | N. *or* S. |

For the remainder of the work, by which the latitudes are found from either the $\varphi'$ $\varphi''$ formula or the reduction to the meridian, employ the methods given under "Form for Latitude Sights of Sun's Lower Limb (Sumner Line)."

### FORM FOR LATITUDE SIGHTS OF A PLANET (SUMNER LINE).

|  | h. m. s. |  |
|---|---|---|
| W. T. | .......... |  |
| C–W | + .......... |  |
| Chro. t. | .......... |  |
| C. C. | ± .......... |  |
| (11) G. M. T. | .......... |  |
| R. A. M. S. | + .......... |  |
| Red. (Tab. 9) | + .......... |  |
| G. S. T. | .......... |  |
| R. A.✶ | .......... |  |
| (12) H. A. from Gr. | .......... E. *or* W. |  |
| (27) Long.₁ | .......... E. *or* W. |  |

$t_1$

| h. m. s. | |
|---|---|
| .......... | |
| o ′ ″ | } E. *or* W. |
| .......... | |

|  | h. m. s. |
|---|---|
| (23) Long.₂ | .......... |

$t_2$

| h. m. s. |
|---|
| .......... |
| o ′ ″ |
| .......... |

|  | o ′ ″ |
|---|---|
| Obs. alt. ✶ | .......... |
| Corr. | ± .......... |
| $h$ | .......... |

| | ′ ″ |
|---|---|
| (15) par. | + .......... |
| (4) I. C. | + .......... |

| | + .......... |
|---|---|
| | ′ ″ |

| dip | − .......... |
|---|---|
| ref. | − .......... |

| − .......... |
|---|

| Corr. | ± .......... |
|---|---|

|  | h. m. s. |  | Dec. | o ′ ″ |  |
|---|---|---|---|---|---|
| R. A. | .......... |  | | .......... | N. *or* S. |
| | | s. | | ″ | |
| H. D. | ± .......... | | H. D. | ± .......... | |
| | | h. | | | h. |
| G. M. T. | .......... | | G. M. T. | .......... | |
| | | s. | | ′ ″ | |
| Corr. | ± .......... | | Corr. | ± .......... | |
| | h. m. s. | | | o ′ ″ | |
| R. A. | .......... | | Dec. | .......... | N. *or* S. |

For the remainder of the work, by which the latitudes are found from either the $\varphi'$ $\varphi''$ formula or the reduction to the meridian, employ the methods given under "Forms for Latitude Sights of Sun's Lower Limb (Sumner Line)."

## FORM FOR LATITUDE SIGHTS OF MOON'S LOWER LIMB (SUMNER LINE).

|  | h. m. s. |  |  | o ′ ″ |  |  | h. m. s. |  |  | o ′ ″ |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| W. T. | .......... | Obs. alt. ☾ | ......... | (17) R. A. | ......... | (17) Dec. | ........ N. or S. |
| C–W | +.......... |  |  |  |  |  |  |
|  |  |  | ′ ″ |  | s. |  | ″ |
| Chro. t. | .......... | (16) S. D. | +........ | M. D. | +........ | M. D. | ±....... |
| C. C. | ±.......... | Aug. | +........ |  | m. |  | m. |
|  |  | (4) I. C. | +........ | No. min. | ±........ | No. min. | ±....... |
| (11) G. M. T. | .......... |  |  |  | s. |  | ′ ″ |
| R. A. M. S. | +.......... |  | +........ | Corr. | ±........ | Corr. | ±....... |
| Red. (Tab. 9) | +.......... |  |  |  |  |  |  |
|  |  |  | ′ ″ |  | h. m. s. |  | o ′ ″ |
| G. S. T. | .......... | dip | –........ | R. A. | ......... | Dec. | ....... N. or S. |
| R. A. ☾ | .......... |  |  |  |  |  |  |
|  |  |  | ′ ″ |  |  |  |  |
| (12) H. A. from Gr. | .......... E. or W. | 1st Corr. | ±........ |  |  |  |  |
| (27) Long.₁ | .......... E. or W. |  |  |  |  |  |  |
|  |  |  | o ′ ″ |  |  |  |  |
|  |  | Approx. alt. | ....... |  |  |  |  |
| t₁ | [h. m. s. / o ′ ″ / ] E. or W. | p. & r. (Tab. 24) | +........ |  |  |  |  |
|  |  |  | o ′ ″ |  |  |  |  |
|  |  | ⚓ | ...... |  |  |  |  |
|  | h. m. s. |  |  |  |  |  |  |
| Long.₂ | .......... E. or W |  |  |  |  |  |  |
| t₂ | [h. m. s. / o ′ ″ / ] |  |  |  |  |  |  |

For the remainder of the work, by which the latitudes are found from either the $\varphi'$ $\varphi''$ formula or the reduction to the meridian, employ the methods given under " Forms for Latitude Sights of Sun's Lower Limb (Sumner Line)."

## FORM FOR CHRONOMETER CORRECTION BY EQUAL ALTITUDES OF SUN.

|  | h. m. s. |  | h. m. s. |  | o ′ ″ |  |  | ″ |
|---|---|---|---|---|---|---|---|---|
| W. T., A. M. | .......... | W. T., P. M. | .......... | (28) Dec. | .......... N. or S. | H. D. (prev. noon) | } ±.......... |
| C–W | +.......... | C–W | +.......... |  | ″ |  |  |
| A. M. Chro. t. | .......... | P. M. Chro. t. | .......... | H. D. at merid. | } ±.......... | H. D. (foll. noon) | } ±.......... |
| P. M. Chro. t. | +.......... | A. M. Chro. t. | –.......... |  | h. |  |  |
|  | 2) .......... | Elap. time | .......... | Long. | ±.......... | Diff. 24ʰ | ±.......... |
| Mid. Chro. t. | .......... |  |  |  | ′ ″ |  | ″ |
| Eq. eq. alt. | ±.......... |  |  | Corr. | ±.......... | Diff. 1ʰ | ±.......... |
| Chro. t. L. A. noon | } .......... |  |  |  | o ′ ″ |  | ″ |
| (7) Eq. t. | ±.......... |  |  | Dec. | .......... N. or S. | Diff. for long. | ±.......... |
| Chro. t. L. M. noon | } .......... |  | m. s. |  |  | H. D. at merid. | ±.......... |
| (29) Long. | ±.......... | (28) Eq. t. | .......... | (31) Tab. 37 | log A (±).... | log B (+)...... |
|  |  |  | s. |  | ″ |  |  |
| (30) Chro. error on G. M. T. | } ±.......... | H. D. | ±.......... | H. D. | ±...... log (±).... | log (±)...... |
|  |  |  | h. | L | ±...... tan (±).... d ±...... tan (±)...... |
|  |  | Long. | ±.......... |  | s. |  |  |
|  |  |  | s. | 1st pt. | ±...... log (±).... |  |
|  |  | Corr. | ±.......... | 2d pt. | ±...... | log (±)...... |
|  |  |  | m. s. | Eq. eq. alt. | } ±...... |  |
|  |  | Eq. t. | .......... |  |  |  |

### FORM FOR FINDING THE TIME OF HIGH (OR LOW) WATER.

|  | d. h. m. |
|---|---|
| G. M. T. of Greenwich transit | .......... |
| (32) Corr. for Long. (Tab. 11) | ±.......... |
| L. M. T. of local transit | .......... |
| Lunitidal int. (App. IV) | +.......... |
| L. M. T. of high (or low) water | .......... |

## NOTES RELATING TO THE FORMS.

1. It is not necessary to convert departure into difference of longitude for each course; it will suffice to make one conversion for the sum of all the departures used in bringing forward the position to any particular time.

2. In D. R. it will be found convenient to work Lat. and Long. in minutes and tenths, rather than in minutes and seconds.

3. If upper limb is observed, the correction for S. D. should be negative, instead of positive.

4. A positive I. C. has been assumed for illustration throughout the forms; if negative, it should be included with the *minus* terms of the correction.

5. For time sights and $\varphi'$ $\varphi''$ sights, take Dec. and Eq. t. from Naut. Alm., p. II (G. M. noon).

6. To obtain $p$, subtract Dec. from 90° if of same name as Lat.; add to 90° if of opposite name.

7. Sign of Eq. t. that of application to *mean* time.

8. If G. A. T. is later than L. A. T., Long. is west; otherwise it is east.

9. If Lat. is exactly known, a second latitude need not be employed.

10. $s_2$ and $s_2-h$ may be obtained by applying half the difference between $L_1$ and $L_2$, with proper sign, to $s_1$ and $s_1-h$, respectively.

11. The G. M. T. must represent the proper number of hours from noon, the beginning of the astronomical day; to obtain this it may be necessary to add 12$^h$ to the Chro. t.

12. H. A. from Greenwich is the difference between G. S. T. and R. A., and should be marked W. if the former is greater; otherwise, E.

13. Local H. A. is marked E. or W., according as the body is east or west of the meridian at time of observation.

14. Subtract local hour angle from Greenwich hour angle to obtain longitude; that is, change name of local hour angle and combine algebraically.

15. The forms include a correction for the parallax of a planet, but in most cases this is small, and may be omitted. When used, take hor. par. from Naut. Alm. and reduce to observed altitude by Table 17. The semidiameter of a planet may be disregarded in sextant work if the *center* of the body is brought to the horizon line.

16. If upper limb is observed, the corrections for S. D. and Aug. should be negative, instead of positive.

17. R. A. and Dec. are to be picked out of Naut. Alm. for nearest hour of G. M. T., and to be corrected for the number of minutes and tenths.

18. Mark zenith distance N. or S. according as zenith is north or south of the body observed; mark Dec. according to its name, subtracting it from 180° for cases of lower transit; then, in combining the two for Lat., have regard to their names.

19. For meridian altitudes, take Dec. from Naut. Alm., p. I (G. A. noon).

20. This form enables "Constant" to be worked up before sight is taken, and gives latitude directly on completion of meridian observation. Longitude and altitude at transit must be known in advance with sufficient accuracy for correcting terms.

21. The details of obtaining Dec. at transit and correction for altitude are shown in the meridian altitude forms for each of the various bodies.

22. In an a. m. sight subtract L. A. T. from 24$^h$ to obtain $t$; in a p. m. sight L. A. T. is equal to $t$.

23. If Long. is exactly known, a second longitude need not be employed.

24. Mark $\varphi''$ N. or S. according to name of Dec., and subtract it from 180° when body is nearer to lower than to upper transit; mark $\varphi'$ N. or S. according as zenith is north or south of the body; then combine for Lat. having regard to the names.

25. Take $a$ from Table 26 and $at^2$ from Table 27.

26. Add for upper, subtract for lower transits.

27. Subtract longitude from Greenwich hour angle to obtain local hour angle; that is, change name of longitude and combine algebraically.

28. For equal altitude sights, take Dec. and Eq. t. from Naut. Alm., p. I (G. A. noon).

29. Add longitude if east; subtract if west.

30. If *error* is +, the chronometer is fast, and the *correction* is subtractive; and the reverse.

31. Mark log A and log B as indicated in Table 37; mark N. Lat., N. Dec., and H. D. toward the north +, and the reverse. If, in combining the three logarithms for the respective parts of the equations, one or three of them should be *minus*, the sign of that part is *minus*; otherwise, *plus*.

32 Add for west, subtract for east longitude.

6583—06——12

## APPENDIX III.

## EXPLANATION OF CERTAIN RULES AND PRINCIPLES OF MATHEMATICS OF USE IN THE SOLUTION OF PROBLEMS IN NAVIGATION.

### DECIMAL FRACTIONS.

*Fractions*, or *Vulgar Fractions*, are expressions for any assignable part of a unit; they are usually denoted by two numbers, placed one above the other, with a line between them; thus $\frac{1}{4}$ denotes the fraction one-fourth, or one part out of four of some whole quantity, considered as divisible into four equal parts. The lower number, 4, is called the *denominator* of the fraction, showing into how many parts the whole is divided; and the upper number, 1, is called the *numerator*, and shows how many of those equal parts are contained in the fraction. It is evident that if the numerator and denominator be varied in the same ratio the value of the fraction will remain unaltered; thus, if both the numerator and denominator of the fraction, $\frac{1}{4}$, be multiplied by 2, 3, 4, etc., the fractions arising will be $\frac{2}{8}$, $\frac{3}{12}$, $\frac{4}{16}$, etc., all of which are evidently equal to $\frac{1}{4}$.

A *Decimal Fraction* is a fraction whose denominator is always a unit with some number of ciphers annexed and the numerator any number whatever; as, $\frac{2}{10}$, $\frac{3}{100}$, $\frac{15}{1000}$, etc. And as the denominator of a decimal is always one of the numbers 10, 100, 1000, etc., the necessity for writing the denominator may be avoided by employing a point; thus, $\frac{3}{10}$ is written .3, and $\frac{14}{100}$ is written .14; the *mixed* number $3\frac{14}{100}$, consisting of a whole number and a fractional one, is written 3.14.

In setting down a decimal fraction the numerator must consist of as many places as there are ciphers in the denominator; and if it has not so many figures the defect must be supplied by placing ciphers before it; thus, $\frac{16}{100} = .16$, $\frac{16}{1000} = .016$, $\frac{16}{10000} = .0016$, etc. And as ciphers on the right-hand side of integers increase their value in a tenfold proportion, as 2, 20, 200, etc., so when set on the left hand of decimal fractions they decrease their value in a tenfold proportion, as .2, .02, .002, etc.; but ciphers set on the right hand of these fractions make no alteration in their value; thus, .2 is the same as .20 or .200.

The common arithmetical operations are performed the same way in decimals as they are in integers, regard being had only to the particular notation, to distinguish the integral from the fractional part of a sum.

ADDITION OF DECIMALS.—Addition of decimals is performed exactly like that of whole numbers, placing the numbers of the same denomination under each other, in which case the separating decimal points will range straight in one column.

EXAMPLES.

|  | Miles. | Feet. | Inches. |
|---|---|---|---|
| Add: | 26.7 | 1.26 | 272.3267 |
|  | 32.15 | 2.31 | .0134 |
|  | 143.206 | 1.785 | 2.1576 |
|  | .003 | 2.0 | 31.4 |
| Sum: | 202.059 | 7.355 | 305.8977 |

SUBTRACTION OF DECIMALS.—Subtraction of decimals is performed in the same manner as in whole numbers, observing to set the figures of the same denomination and the separating points directly under each other.

EXAMPLES.

| From: | 31.267 | 36.75 | 1.254 | 1364.2 |
|---|---|---|---|---|
| Take: | 2.63 | .026 | .316 | 25.163 |
| Difference: | 28.637 | 36.724 | .938 | 1339.037 |

MULTIPLICATION OF DECIMALS.—Multiply the numbers together as if they were whole numbers, and point off as many decimals from the right hand as there are decimals in both factors together; and when it happens that there are not so many figures in the product as there must be decimals, then prefix such number of ciphers to the left hand as will supply the defect.

### EXAMPLE I.

Multiply 3.25 by 4.5.

$$3.25$$
$$4.5$$

$$1.625$$
$$13.00$$

Answer: 14.625

In one of the factors is one decimal, and in the other two; their sum, 3, is the number of decimals of the product.

### EXAMPLE II.

Multiply .17 by .06.

$$.17$$
$$.06$$

Answer: .0102

In each of the factors are two decimals; the product ought therefore to contain 4; and, there being only three figures in the product, a cipher must be prefixed.

EXAMPLE III.

Multiply 0.5 by 0.7.

$$0.5$$
$$0.7$$

Answer:　0.35

EXAMPLE IV.

Multiply .18 by 24.

$$.18$$
$$24$$

$$72$$
$$36$$

Answer:　4.32

DIVISION OF DECIMALS.—Division of decimals is performed in the same manner as in whole numbers. The number of decimals in the quotient must be equal to the excess of the number of decimals of the dividend above those of the divisor; when the divisor contains more decimals than the dividend, ciphers must be affixed to the right hand of the latter to make the number equal or exceed that of the divisor.

EXAMPLE I.

Divide 14.625 by 3.25.

3.25 ) 14.625 ( 4.5
　　　1300

　　　1625
　　　1625

In this example there are two decimals in the divisor and three in the dividend; hence, there is one decimal in the quotient.

EXAMPLE II.

Divide 3.1 by .0062.

Previous to the division affix three ciphers to the right hand of 3.1, to make the number of decimals in the dividend equal the number in the divisor.

.0062 ) 3.1000 ( 500
　　　　310

　　　　000

EXAMPLE III.

Divide 17.256 by 1.16.

1.16 ) 17.25600 ( 14.875
　　　116

　　　565
　　　464

　　　1016
　　　928

　　　880
　　　812

　　　680
　　　580

　　　100

MULTIPLICATION OF DECIMALS BY CONTRACTION.—The operation of multiplication of decimal fractions may be very much abbreviated when it is not required to retain any figures beyond a certain order or place; this will constantly occur in reducing the elements taken from the Nautical Almanac from Greenwich noon to later or earlier instants of time.

In multiplying by this method, omit writing down that part of the operation which involves decimal places below the required order, but mental note should be made of the product of the first discarded figure by the multiplying figure, and the proper number of tens should be carried over to insure accuracy in the lowest decimal place sought.

EXAMPLE: Required the reduction for the sun's declination for $7^h.43$, the hourly difference being $58''.18$, where the product is required to the second decimal.

|  | *By ordinary method.* | *By contraction.* |
|---|---|---|
|  | $58''.18$ | $58''.18$ |
|  | $7^h.43$ | $7^h.43$ |
|  | 17454 | 1.74 |
|  | 23272 | 23.27 |
|  | 40726 | 407.26 |
|  | $432''.2774$ | $432.''27$ |

In the contracted method, for the multiplier .03 it is not necessary to record the product of any figures in the multiplicand below units; for the multiplier .4, none below tenths; but in each case observe the product of the left-hand one of the rejected figures and carry forward the number of tens.

REDUCTION OF DECIMALS.—To reduce a vulgar fraction to a decimal, add any number of ciphers to the numerator and divide it by the denominator; the quotient will be the decimal fraction. The decimal point must be so placed that there may be as many figures to the right hand of it as there were added ciphers to the numerator. If there are not so many figures in the quotient place ciphers to the left hand to make up the number.

### EXAMPLE 1.

Reduce $\frac{1}{50}$ to a decimal.

50)1.00
_____
.02 Answer.

### EXAMPLE II.

Reduce $\frac{3}{8}$ to a decimal.

8)3.000
_____
.375 Answer.

### EXAMPLE III.

Reduce 3 inches to the decimal of a foot.
Since 12 inches = 1 foot this fraction is $\frac{3}{12}$.

12)3.00
_____
.25 Answer.

### EXAMPLE IV.

Reduce 15 minutes to the decimal of an hour.
Since $60^m = 1^h$, this fraction is $\frac{15}{60}$.

60)15.00
_____
.25 Answer.

### EXAMPLE V.

Reduce $17^m$ $22^s$ to the decimal of an hour.

$$22^s = \frac{22^m}{60} = 0^m.37.$$

$$17^m.37 = \frac{17^h.37}{60} = 0^h.289 \text{ Answer.}$$

Any decimal may be reduced to lower denominations of the same quantity by multiplying it by the number representing the relation between the respective denominations.

EXAMPLE VI: Reduce 7.231 days to days, hours, minutes, and seconds.

| $0^d.231$ | $0^h.544$ | $0^m.640$ |
|---|---|---|
| 24 | 60 | 60 |
| 924 | $32^m.640$ | $38^s.400$ |
| 462 | | |
| $5^h.544$ | | |

Answer: $7^d$ $5^h$ $32^m$ $38^s.4.$

## GEOMETRY.

Geometry is the science which treats of the description, properties, and relations of magnitudes, of which there are three kinds; viz, a line, which has only length without either breadth or thickness; a surface, comprehended by length and breadth; and a solid, which has length, breadth, and thickness.

A point, considered mathematically, has neither length, breadth, nor thickness; it denotes position simply.

A line has length without breadth or thickness.

A surface has length and breadth without thickness.

A solid has length, breadth, and thickness.

A straight or right line is the shortest distance between two points on a plane surface.

A plane surface is one in which, any two points being taken, the straight line between them lies wholly within that surface.

Parallel lines are such as are in the same plane and if extended indefinitely never meet.

A circle is a plane figure bounded by a curve line of which every point is equally distant from a point within called the center. The bounding curve of the circle is called the circumference.

The radius of a circle, or semi-diameter, is a right line drawn from the center to the circumference, as AC (fig. 65); its length is that distance which is taken between the points of the compasses to describe the circle.

A diameter of a circle is a right line drawn through the center and terminated at both ends by the circumference, as ACB, its length being twice that of the radius. A diameter divides the circle and its circumference into two equal parts.

An arc of a circle is any portion of the circumference, as DFE.

The chord of an arc is a straight line joining the ends of the arc. It divides the circle into two unequal parts, called segments, and is a chord to them both; thus, DE is the chord of the arcs DFE and DGE.
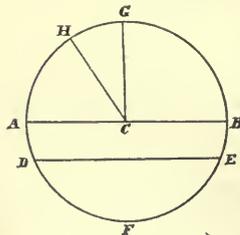
FIG. 65.

A semicircle, or half circle, is a figure contained between a diameter and the arc terminated by that diameter, as AGB or AFB.

Any part of a circle contained between two radii and an arc is called a *sector*, as GCH.

A *quadrant* is half a semicircle, or one-fourth part of a whole circle, as CAG.

All circles are supposed to have their circumferences divided into 360 equal parts, called degrees; each degree is divided into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds; an arc is measured by the number of degrees, minutes, and seconds that it contains.

A *sphere* is a solid bounded by a surface of which every point is equally distant from a point within which, as in the circle, is called the *center*. Substituting *surface* for *circumference*, the definitions of the *radius* and *diameter*, as given for the circle, apply for the sphere.

An *angle* is the inclination of two intersecting lines, and is measured by the arc of a circle intercepted between the two lines that form the angle, the center of the circle being the point of intersection.

A *right angle* is one that is measured by a quadrant, or 90°. An *acute angle* is one which is less than a right angle. An *obtuse angle* is one which is greater than a right angle.

A *plane triangle* is a figure contained by three straight lines in the same plane.

When the three sides are equal, the triangle is called *equilateral;* when two of them are equal, it is called *isosceles*. When one of the angles is 90°, the triangle is said to be *right-angled*. When each angle is less than 90°, it is said to be *acute-angled*. When one is greater than 90°, it is said to be *obtuse-angled*. Triangles that are not right-angled are generally called *oblique-angled*.

A *quadrilateral* figure is one bounded by four sides. If the opposite sides are parallel, it is called a *parallelogram*. A parallelogram having all its sides equal and its angles right angles is called a *square*. When the angles are right angles and only the opposite sides equal, it is called a *rectangle*.

In a right-angled triangle the side opposite the right angle is called the *hypotenuse*, one of the other sides is called the *base*, and the third side is called the *perpendicular*. In any oblique-angled triangle, one side having been assumed as a base, the distance from the intersection of the other two sides to the base or the base extended, measured at right angles to the latter, is the perpendicular. In a parallelogram, one of the sides having been assumed as the base, the distance from its opposite side, measured at right angles to its direction, is the perpendicular. The term *altitude* is sometimes substituted for *perpendicular* in this sense.

Every section of a sphere made by a plane is a circle. A *great circle* of a sphere is a section of the surface made by a plane which passes through its center. A *small circle* is a section by a plane which intersects the sphere without passing through the center.

A great circle may be drawn through any two points on the surface of a sphere, and the arc of that circle lying between those points is shorter than any other distance between them that can be measured upon the surface. All great circles of a sphere have equal radii, and all bisect each other.

The extremities of that diameter of the sphere which is perpendicular to the plane of a circle are called the *poles* of that circle. In the case of a small circle the poles are named the *adjacent pole* and the *remote pole*. All circles of a sphere that are parallel have the same poles. All points in the circumference of a circle are equidistant from the poles. In the case of a great circle, the poles are 90° distant from every point of the circle.

Assuming any great circle as a *primary*, all great circles which pass through its poles are called its *secondaries*. All secondaries cut the primary at right angles.

USEFUL FORMULÆ DERIVED FROM GEOMETRY.—In these formulæ the following abbreviations are adopted:

$b$, base of triangle or parallelogram.
$h$, perpendicular of triangle or parallelogram.
$l$, height of cylinder or cone.
$\pi$, ratio of diameter to circumference ($= 3.141593$).

$r$, radius of sphere or circle.
$d$, diameter of sphere or circle.
A, major axis of ellipse.
$a$, minor axis of ellipse.
$s$, side of a cube.

Area of parallelogram $= b \times h$.
Area of triangle $= \frac{1}{2} b \times h$.
Area of any right-lined figure = sum of the areas of the triangles into which it is divided.
Sum of three angles of any triangle $= 180°$.
Circumference of circle $= 2\pi r$, or $\pi d$.

Area of circle $= \pi r^2$, or $\dfrac{\pi d^2}{4}$.

Angle subtended by arc equal to radius $= 57°.29578$.

Volume of sphere $= \dfrac{\pi d^3}{6}$.

Surface of sphere $= \pi d^2$, or $4\pi r^2$.

Area of ellipse $= \dfrac{\pi A a}{4}$.

Volume of cube $= s^3$.

Volume of cylinder $=$ Area of base $\times l$.

Volume of pyramid or cone $=$ Area of base $\times \dfrac{l}{3}$.

## TRIGONOMETRIC FUNCTIONS.
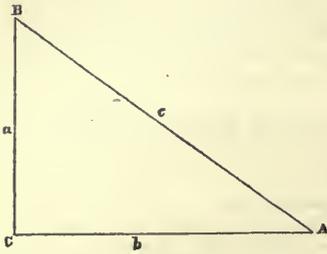
The *trigonometric functions* of the angle formed by any two lines are the *ratios* existing between the sides of a right triangle formed by letting fall a perpendicular from any point in one line upon the other line; no matter what point is chosen for the perpendicular nor which line, the ratios, and therefore the respective functions, will be the same for any given angle.

Let ABC (fig. 66) be a plane right triangle in which C is the right angle; A and B, the other angles; c, the hypotenuse; a and b the sides opposite the angles A and B, respectively. In considering the functions of the angle A, its opposite side, a, is regarded as the perpendicular and adjacent side, b, as the base; for the angle B, b is the perpendicular and a the base. Then the various ratios are designated as follows:

FIG. 66.

$\dfrac{a}{c}$, or $\dfrac{\text{perpendicular}}{\text{hypotenuse}}$, is called the *sine* of angle A, abbreviated sin A;

$\dfrac{b}{c}$, or $\dfrac{\text{base}}{\text{hypotenuse}}$, is called the *cosine* of angle A, abbreviated cos A;

$\dfrac{a}{b}$, or $\dfrac{\text{perpendicular}}{\text{base}}$, is called the *tangent* of the angle A, abbreviated tan A;

$\dfrac{b}{a}$, or $\dfrac{\text{base}}{\text{perpendicular}}$, is called the *cotangent* of the angle A, abbreviated cot A;

$\dfrac{c}{b}$, or $\dfrac{\text{hypotenuse}}{\text{base}}$, is called the *secant* of the angle A, abbreviated sec A;

$\dfrac{c}{a}$, or $\dfrac{\text{hypotenuse}}{\text{perpendicular}}$, is called the *cosecant* of the angle A, abbreviated cosec A;

1 — cosine A, is called the *versed sine* of A, abbreviated vers A.

1 — sine A, is called the *co-versed sine* of A, abbreviated covers A.

The following relations may be seen to exist between the various functions:

$$\frac{1}{\sin A} = 1 \div \frac{a}{c} = \frac{c}{a} = \text{cosec A};$$

$$\frac{1}{\cos A} = 1 \div \frac{b}{c} = \frac{c}{b} = \text{sec A};$$

$$\frac{1}{\tan A} = 1 \div \frac{a}{b} = \frac{b}{a} = \text{cot A};$$

$$\frac{\sin A}{\cos A} = \frac{a}{c} \div \frac{b}{c} = \frac{a}{b} = \text{tan A}.$$

Hence the cosecant is the reciprocal of the sine, the secant is the reciprocal of the cosine, the cotangent is the reciprocal of the tangent, and the tangent equals the sine divided by the cosine.

The *complement* of an angle is equal to 90° minus that angle, and thus in the triangle ABC the angle B is the complement of A. The *supplement* is equal to 180° minus the angle.

From the triangle ABC, regarding the angle B, we have:

$$\sin B = \frac{b}{c} = \cos A;$$

$$\tan B = \frac{b}{a} = \cot A;$$

$$\sec B = \frac{c}{a} = \text{cosec A}.$$

Hence it may be seen that the sine of an angle is the cosine of the complement of that angle; the tangent of an angle is the cotangent of its complement, and the secant of an angle is the cosecant of its complement.

The functions of angles vary in sign according to the quadrant in which the angles are located.

Let AA' and BB' (fig. 67) be two lines at right angles intersecting at the point O, and let that point be the center about which a radius revolves from an initial position OB, successively passing the points A, B', A'. In considering the angle made by this radius at any position, P', P'', P''', P'''', with the line OB, its position of origin, the functions will depend upon the ratios existing between the sides of a right triangle whose base, $b$, will always lie within BB,' and whose perpendicular, $a$, will always be parallel to AA', while its hypotenuse, $c$ (of a constant length equal to that of the radius), will depend upon the position occupied by the radius. Now, if OB and OA be regarded as the positive directions of the base and perpendicular, respectively, and OB' and OA' as their negative directions, the sign of the hypotenuse being always positive, the sign of any function may be determined by the signs of the sides of the triangle upon which it depends.
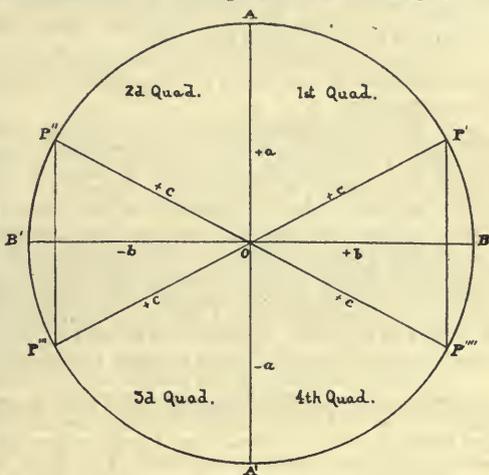


FIG. 67.

For example, the sine of the angle P''OB is $\frac{a}{c}$, and since $a$ is positive the quantity has a positive value; its cosine is $\frac{b}{c}$, and as $b$ is measured in a negative direction from O the cosine must therefore be negative.

In the first quadrant, between 0° and 90°, all quantities being positive, all functions will also be positive.

In the second quadrant, between 90° and 180°, sin A $\left(=\frac{a}{c}\right)$ is positive; cos A $\left(=\frac{b}{c}\right)$ has a negative value because $b$ is negative; tan A $\left(=\frac{a}{b}\right)$ is also negative because of $b$. The cosecant, secant, and cotangent have, as in all cases, the same signs as the sine, cosine, and tangent, respectively, being the reciprocals of those quantities.

In the third quadrant, between 180° and 270°, sin A $\left(=\frac{a}{c}\right)$ and cos A $\left(=\frac{b}{c}\right)$ are both negative, because both $a$ and $b$ have negative values; tan A $\left(=\frac{a}{b}\right)$ is positive for the same reason.

In the fourth quadrant, between 270° and 360°, sin A $\left(=\frac{a}{c}\right)$ is negative, cos A $\left(=\frac{b}{c}\right)$ is positive, and tan A $\left(=\frac{a}{b}\right)$ is also negative.

From a consideration of the signs in the manner that has been indicated the following relations will appear:

$$\sin A = \sin (180°-A) = -\sin (180°+A) = -\sin (360°-A).$$
$$\cos A = -\cos (180°-A) = -\cos (180°+A) = \cos (360°-A).$$
$$\tan A = -\tan (180°-A) = \tan (180°+A) = -\tan (360°-A).$$
$$\sin A = \cos (90°-A) = -\cos (90°+A) = -\cos (270°-A) = \cos (270°+A).$$

Any similar relation may be deduced from the figure.

It is of great importance to have careful regard for the signs of the functions in all trigonometrical solutions.

## LOGARITHMS.

In order to abbreviate the tedious operations of multiplication and division with large numbers, a series of numbers, called *Logarithms*, was invented by Lord Napier, by means of which the operation of multiplication may be performed by addition, and that of division by subtraction. Numbers may be involved to any power by simple multiplication and the root of any power extracted by simple division.

In Table 42 are given the logarithms of all numbers, from 1 to 9999; to each one must be prefixed an index, with a period or dot to separate it from the other part, as in decimal fractions; the numbers from 1 to 100 are given in that table with their indices; but from 100 to 9999 the index is left out for the sake of brevity; it may be supplied, however, by the general rule that the index of the logarithm of any

integer or mixed number is always one less than the number of integral places in the natural number. Thus, the index of the logarithm of any number (integral or mixed) between 10 and 100 is 1; from 100 to 1000 it is 2; from 1000 to 10000 it is 3, etc.; the method of finding the logarithms from this table will be evident from the rules that follow:

*To find the logarithm of any number less than 100,* enter the first page of the table, and opposite the given number will be found the logarithm with its index prefixed. Thus, opposite 71 is 1.85126, which is its logarithm.

*To find the logarithm of any number between 100 and 1000,* find the given number in the left-hand column of the table of logarithms, and immediately under 0 in the next column is a number, to which must be prefixed the number 2 as an index (because the number consists of three places of figures), and the required logarithm will be found. Thus, if the logarithm of 149 was required, this number being found in the left-hand column, against it, in the column marked 0 at the top (or bottom) is found 17319, prefixing to which the index 2, we have the logarithm of 149, 2.17319.

*To find the logarithm of any number between 1000 and 10000,* find the three left-hand figures of the given number in the left-hand column of the table of logarithms, opposite to which, in the column that is marked at the top (or bottom) with the fourth figure, is to be found the required logarithm, to which must be prefixed the index 3, because the number contains four places of figures. Thus, if the logarithm of 1495 was required, opposite to 149, and in the column marked 5 at the top (or bottom) is 17464, to which prefix the index 3, and we have the logarithm, 3.17464.

*To find the logarithm of any number above 10000,* find the first three figures of the given number in the left-hand column of the table, and the fourth figure at the top or bottom, and take out the corresponding logarithm as in the preceding rule; take also the difference between this logarithm and the next greater, and multiply it by the remaining figure or figures of the number whose logarithm is sought, pointing off as many decimal places in the product as there are figures in the multiplier. To facilitate the calculation of the proportional parts several small tables are placed in the margin, which give the correction corresponding to the difference, and to the *fifth* figure of the proposed number. Thus, if the logarithm of 14957 was required, opposite to 149, and under 5, is 17464; the difference between this and the next greater number, 17493, is 29; this multiplied by 7 (the last figure of the given number) gives 203; pointing off the right-hand figure gives 20.3 (or 20) to be added to 17464, which makes 17484; to this, prefixing the index 4, we have the logarithm sought, 4.17484. This correction, 20, may also be found by inspection in the small table in the margin, marked at the top 29; opposite to the *fifth* figure of the number, 7, in the left-hand column, is the corresponding correction, 20, in the right-hand column.

Again, if the logarithm of 1495738 was required, the logarithm corresponding to 149 at the left, and 5 at the top, is, as in the last example, 17464; the difference between this and the next greater is 29; multiplying this by 738 (the given number excluding the first four figures) gives 21402; crossing off the three right-hand figures of this product (because the number 738 consists of three figures), we have the correction 21 to be added to 17464; and the index to be prefixed is 6, because the given number consists of 7 places of figures; therefore the required logarithm is 6.17485. This correction, 21, may be found as above, by means of the marginal table marked at the top 29, taking at the side 7.38 (or 7⅓ nearly), to which corresponds 21, as before.

*To find the logarithm of any mixed decimal number,* find the logarithm of the number, as if it were an integer, by the preceding rules, to which prefix the index of the integral part of the given number. Thus, if the logarithm of the mixed decimal 149.5738 was required, find the logarithm of 1495738, without noticing the decimal point; this, in the last example, was found to be 17485; to this prefix the index 2, corresponding to the integral part 149; the logarithm sought will therefore be 2.17485.

*To find the logarithm of any decimal fraction less than unity,* it must be observed that the index of the logarithm of any number less than unity is negative; but, to avoid the mixture of positive and negative quantities, it is common to borrow 10 in the index, which, in most cases, may afterwards be neglected in summing them with other indices; thus, instead of writing the index − 1 it is written +9; instead of − 2 we may write + 8; and so on. In this way we may find the logarithm of any decimal fraction by the following rule: Find the logarithm of a fraction as if it were a whole number; see how many ciphers precede the first figure of the decimal fraction, subtract that number from 9, and the remainder will be the index of the logarithm of the given fraction. Thus the logarithm of 0.0391 is 8.59218 − 10; the logarithm of 0.25 is 9.39794 − 10; the logarithm of 0.0000025 is 4.39794 − 10, etc. In most cases the writing of − 10 after the logarithm may be dispensed with, as it will be quite apparent whether the logarithm has a positive or a negative index.

*To find the number corresponding to any logarithm,* seek in the column marked 0 at top and bottom the next smallest logarithm, neglecting the index; write down the number in the side column abreast which this is found and this will give the first three figures of the required number; carry the eye along the line until the next smallest logarithm to the given one is found, and the fourth figure of the required number will be at the top and bottom of the column in which this stands; take the difference between this next smallest logarithm and the next larger one in the table, and also the difference between the next smallest logarithm and the given one; entering the small marginal table which has for its heading the first-named difference and finding in the right-hand column of that table the last-named difference, there will appear abreast the latter, in the left-hand column, the fifth figure of the required number. Where it is desired to determine figures beyond the fifth for the corresponding number, the difference between the next lower logarithm and the given one may be divided by the difference between the next lower and next higher ones, and the quotient (disregarding the decimal point, but retaining any ciphers that may come between the decimal point and the significant figures) will be the fifth and succeeding figures of the number sought. Having found the figures of the corresponding number, point off from the left a number of figures which shall be one greater than the index number, and there place a decimal point. In this operation of placing the decimal point, proper account must be taken of the negative value of any index.

Thus, if the number corresponding to the logarithm 1.52634 were required, find 52634 in the column marked 0 at the top or bottom, and opposite to it is 336; now, the index being 1, the required number must consist of two integral places; therefore it is 33.6.

If the number corresponding to the logarithm 2.57345 were required, look in the column 0 and find in it, against the number 374, the logarithm 57287, and, guiding the eye along that line, find the given logarithm, 57345, in the column marked 5; therefore the mixed number sought is 3745, and since the index is 2, the integral part must consist of 3 places; therefore the number sought is 374.5. If the index be 1 the number will be 37.45, and if the index be 0 the number will be 3.745. If the index be 8, corresponding to a number less than unity, the number will be 0.03745.

Again, if the number corresponding to the logarithm 3.57811 were required, find, against 378 and under 5, the logarithm 57807, the difference between this and the next greater logarithm, 57818, being 11, and the difference between 57807 and the given number, 57811, being 4; in the marginal table headed 11, find in the right hand column the number 4, and abreast the latter appears the figure 4, which is the fifth figure of the required number; hence the figures are 37854; pointing off from the left 3+1=4 places, the number is 3785.4.

If the given logarithm were 5.57811, since the index 5 requires that there shall be six places in the whole number, it is desirable to seek accuracy to the sixth figure. The logarithmic part being the same as in the example immediately preceding, it is found as before that the first four figures are 3785, the difference between the next lower and next greater logarithms is 11, and between the next lower logarithm and the given one is 4; divide 4 by 11 and the quotient is .36; drop the decimal point, annex and point off, and the number required is found to be 378536.

It may be remarked that in using five-place logarithm tables it is not generally to be expected that results will be exact beyond the fifth figure.

To show, at one view, the indices corresponding to mixed and decimal numbers, the following examples are given:

| Mixed number. | Logarithms. | Decimal number. | Logarithms. |
|---|---|---|---|
| 40943. 0 ........................Log. | 4. 61218 | 0. 40943.......................Log. | 9. 61218 — 10 |
| 4094. 3 .........................Log. | 3. 61218 | 0. 040943......................Log. | 8. 61218 — 10 |
| 409. 43 .........................Log. | 2. 61218 | 0. 0040943.....................Log. | 7. 61218 — 10 |
| 40. 943 .........................Log. | 1. 61218 | 0. 00040943....................Log. | 6. 61218 — 10 |
| 4. 0943 .........................Log. | 0. 61218 | 0. 000040943...................Log. | 5. 61218 — 10 |

*To perform multiplication by logarithms,* add the logarithms of the two numbers to be multiplied and the sum will be the logarithm of their product.

<div style="display:flex">

### EXAMPLE I.

Multiply 25 by 35.

| | |
|---|---|
| 25.......................Log. | 1. 39794 |
| 35.......................Log. | 1. 54407 |

Product, 875........................Log. 2. 94201

### EXAMPLE II.

Multiply 22.4 by 1.8.

| | |
|---|---|
| 22. 4.....................Log. | 1. 35025 |
| 1. 8......................Log. | 0. 25527 |

Product, 40. 32........................Log. 1. 60552

### EXAMPLE III.

Multiply 3.26 by 0.0025.

| | |
|---|---|
| 3. 26.....................Log. | 0. 51322 |
| 0. 0025...................Log. | 7. 39794 |

Product, 0. 00815.....................Log. 7. 91116

### EXAMPLE IV.

Multiply 0.25 by 0.003.

| | |
|---|---|
| 0. 25.....................Log. | 9. 39794 |
| 0. 003....................Log. | 7. 47712 |

Product, 0. 00075.....................Log. 6. 87506

</div>

In the last example, the sum of the two logarithms is really 16.87506—20; this is the same as 6.87506 — 10, or, remembering that the quantity is less than unity, simply 6.87506.

*To perform division by logarithms,* from the logarithm of the dividend subtract the logarithm of the divisor; the remainder will be the logarithm of the quotient.

<div style="display:flex">

### EXAMPLE I.

Divide 875 by 25.

| | |
|---|---|
| 875 ......................Log. | 2. 94201 |
| 25 .......................Log. | 1. 39794 |

Quotient, 35 ......................Log. 1. 54407

### EXAMPLE II.

Divide 40.32 by 22.4.

| | |
|---|---|
| 40. 32 ...................Log. | 1. 60552 |
| 22. 4 ....................Log. | 1. 35025 |

Quotient, 1.8 ....................Log. 0. 25527

### EXAMPLE III.

Divide 0.00815 by 0.0025.

| | |
|---|---|
| 0.00815 ..................Log. | 7. 91116 |
| 0.0025 ...................Log. | 7. 39794 |

Quotient, 3.26 ....................Log. 0. 51322

### EXAMPLE IV.

Divide 0.00075 by 0.025.

| | |
|---|---|
| 0.00075 ..................Log. | 6. 87506 |
| 0.025 ....................Log. | 8. 39794 |

Quotient, 0.03........................Log. 8.47712

</div>

In Example III both the divisor and dividend are fractions less than unity, and the divisor is the lesser; consequently the quotient is greater than unity. In Example IV both fractions are less than unity; and, since the divisor is the greater, its logarithm is greater than that of the dividend; for this reason it is necessary to borrow 10 in the index before making the subtraction, that is, to regard the logarithm of .00075 as 16.87506 — 20; hence the quotient is less than unity.

The *arithmetical complement of a logarithm* is the difference between that logarithm and the logarithm of unity (10.00000—10, or 0.00000). It is therefore the logarithm of unity divided by that number which is the reciprocal of the number; and, since the effect of dividing by any number is the same as that of multiplying by its reciprocal, it follows that, in performing division by logarithms, we may either subtract the logarithm of the divisor or add the arithmetical complement of that logarithm. As the addition of a number of quantities can be performed in a single operation, while in subtraction the difference between only two quantities can be taken at a time, it is frequently a convenience to deal with the arithmetical complements rather than with the logarithms themselves.

### EXAMPLE I.

Divide 875 by 25.

875 .........................Log. 2. 94201
25........Log. 1.39794....Colog. 8. 60206

Quotient, 35.........................Log. 1. 54407

### EXAMPLE II.

Divide 0.00075 by 0.025.

0.00075.....................Log. 6. 87506
0.025 .....Log. 8.39794....Colog. 1. 60206

Quotient, 0.03 .....................Log. 8. 47712

### EXAMPLE III.

Simplify the expression, $\dfrac{40.32 \times .00815}{22.4 \times .0025}$ .

40.32 .........................Log. 1. 60552
.00815 .........................Log. 7. 91116
22.4 ........Log. 1.35025.....Colog. 8. 64975
.0025 .....Log. 7.39794.....Colog. 2. 60206

Result, 5.868 .........................Log. 0. 76849

*To perform involution by logarithms*, multiply the logarithm of the given number by the index of the power to which the quantity is to be raised; the product will be the logarithm of the power sought.

### EXAMPLE I.

Required the square of 18.

18 .........................Log. 1. 25527
................................................2

Answer, 324.........................Log. 2. 51054

### EXAMPLE II.

Required the square of 6.4.
6.4 ........................ Log. 0. 80618
................................................2

Answer, 40.96 ...................... Log. 1. 61236

### EXAMPLE III.

Required the cube of 13.

13 .........................Log. 1. 11394
................................................3

Answer, 2197.........................Log. 3. 34182

### EXAMPLE IV.

Required the cube of 0.25.

0.25 ........................ Log. 9. 39794
................................................3

Answer, 0.015625 .................... Log. 8. 19382

In the last example, the full product of the multiplication of 9.39794—10 by 3 is 28.19382—30, which is equivalent to 8.19382—10.

*To perform evolution by logarithms* divide the logarithm of the number by the index of the power; the quotient will be the logarithm of the root sought. If the number whose root is to be extracted is a decimal fraction less than unity, increase the index of its logarithm by adding a number of tens which shall be less by one than the index of the power before making the division.

### EXAMPLE I.

Required the square root of 324.

324 ........................ Log. 2) 2. 51055

Answer, 18 ...................... Log.    1. 25527

### EXAMPLE II.

Required the cube root of 2197.

2197 ...................... Log. 3) 3. 34183

Answer,   13 ...................... Log.    1. 11394

### EXAMPLE III.

Required the square root of 40.96.

40.96...................... Log. 2) 1. 61236

Answer, 6.4...................... Log.    0. 80618

### EXAMPLE IV.

Required the cube root of 0.015625.

0.015625................ Log.    8. 19382
Add 20 to the index .................. 3)28. 19382

Answer, 0.25...................... Log.    9. 39794

In the last example the logarithm 8.19382—10 was converted into its equivalent form of 28.19382—30, which, divided by 3, gives 9.39794—10.

*To find the logarithm of any function of an angle,* Table 44 must be employed. This table is so arranged that on every page there appear the logarithms of all the functions of a certain angle A, together with those of the angles 90°—A, 90°+A, and 180°—A; thus on each page may be found the logarithms of the functions of four different angles. The number of degrees in the respective angles are printed in bold-faced type, one in each corner of the page; the number of minutes corresponding appear in one column at the left of the page and another at the right; the names of the functions

to which the various logarithms correspond are printed at the top and bottom of the columns. The invariable rule must be to take the name of the function from the top or the bottom of the page, according as the number of degrees of the given angle is found at the top or bottom; and to take the minutes from the right or left hand column, according as the number of degrees is found at the right or left hand side of the page; or, more briefly, take names of functions and number of minutes, respectively, from the line and column nearest in position to the number of degrees.

Taking, as an example, the thirty-first page of the table, it will be found that 30° appears at the upper left-hand corner, 149° at the upper right-hand, 59° at the lower right-hand, and 120° at the lower left-hand corner. Suppose that it is desired to find the log. sine of 30° 10′; following the rule given, we find 10′ in the left-hand column and Sine at the top of the page, and abreast one and below the other is the required logarithm, 9.70115. But if the log. sine of 59° 10′ were sought, as 59° appears below and at the right of the page, the logarithm 9.93382 would be taken from the column marked Sine at the bottom and abreast 10′ on the right. It may also be seen that log. sin 30° 10′ = log. cos 59° 50′ = log. cos 120° 10′ = log. sin 149° 50′ = 9.70115, the equality of the functions agreeing with trigonometrical deductions; (in this statement numerical values only are regarded, and not signs; the latter must, of course, be taken into account in all operations).

| EXAMPLE I. | EXAMPLE II. |
|---|---|

Required the log. sine, cosecant, tangent, cotangent, secant, and cosine of 28° 37′.

| Log. sin | 9. 68029 | Log. cot 10. 26313 |
| Log. cosec 10. 31971 | Log. sec 10. 05658 |
| Log. tan | 9. 73687 | Log. cos | 9. 94342 |

Required the log. sine, cosecant, tangent, cotangent, secant, and cosine of 75° 42′.

| Log. sin | 9. 98633 | Log. cot | 9. 40636 |
| Log. cosec 10. 01367 | Log. sec 10. 60730 |
| Log. tan | 10. 59364 | Log. cos | 9. 39270 |

When the angle of which the logarithmic function is required is given to seconds, it becomes necessary to interpolate between the logarithms given for the even minutes next below and next above; this may be done either by computation or (except in a few cases) by inspection of the table.

To interpolate by computation, let $n$ represent the number of seconds, D the difference between the logarithms of the next less and next greater even minute, and $d$ the difference between the logarithm of the next less even minute and that of the required angle. Then,

$$d = \frac{n}{60} \times D.$$

It should be noted when the number of seconds is 30, 20, 15, or some similar number, permitting the reduction of the fraction $\frac{n}{60}$ to a simple value, such as $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, as the interpolation by this method may thus be made with greater facility.

Having obtained the difference of the logarithm from that of the next lower even minute, it must be applied in the proper direction—that is, if the function is such that its logarithm increases as the angle increases, the logarithmic difference must be added; but if it decreases, then that difference must be subtracted.

For example, let it be required to find the log. sin and log. cosec of 30° 10′ 19″. The log. sin of 30° 10′ is 9.70115; the difference between this logarithm and that of the sine of 30° 11′ (9.70137) is +22, which is D. Hence,

$$d = \frac{19}{60} \times (+22) = +7;$$

and the required logarithm is 9.70122. The log. cosec of 30° 10′ is 10.29885; the difference, D, between that and log. sin 30° 11′ (10.29863) is − 22. In this case

$$d = \frac{19}{60} \times (-22) = -7;$$

therefore, log. cosec 30° 10′ 19″ = 10.29878.

The method of interpolating by inspection consists in entering that column marked "Diff." which is adjacent to the one from which the logarithmic function for the next lower minute is taken, and finding, abreast the number in the left-hand minute column which corresponds to the seconds, the required logarithmic difference; and the latter is to be added or subtracted according as the logarithms increase or decrease with an increased angle. Thus, if it be required to find log. sin 30° 10′ 19″, find as before log. sin 30° 10′ = 9.70115; then, in the adjacent column headed "Diff." and abreast the number of seconds, 19, in the left-hand minute column will be found 7, the logarithmic difference; add this, as the function is increasing, and we have the required logarithm 9.70122. If log. cosec 30° 10′ 19″ be sought, find log. cosec 30° 10′ = 10.29885; then in the adjacent difference column, which is the same as was used for the sines, find as before the logarithmic difference, 7; and since this function decreases as the angle increases, this must be subtracted; therefore, log. cosec 30° 10′ 19″ = 10.29878.

This method of interpolation by inspection is not available in that portion of the table where the logarithmic differences vary so rapidly that no values will apply alike to all the angles on the same page; on such pages the difference for one minute is given in a column headed "Diff. 1′," instead of the usual difference for each second; in this case, the interpolation must be made by computation, the given difference for one minute being D. In other parts of the table the interpolation by inspection may be liable to slight error because of the variation in logarithmic difference for different angles on the same page; but the tabulated values are sufficiently accurate for the usual calculations in navigation.

It will be evident that while the methods explained have contemplated entering the tables with a smaller angle and interpolating *ahead*, it would be equally correct to enter with a greater angle and interpolate *back* for the proper number of minutes, making the requisite change in the sign of the correction.

| EXAMPLE I. | | EXAMPLE II. | |
|---|---|---|---|

Required the log. sine, cosine, and tangent of 42° 57′ 06″.

Required the log. secant, cosecant, and cotangent of 175° 32′ 36″.

| | For 42° 57′ | $d$ | For 42° 57′ 06″. | | For 175° 32′ | $d$ | For 175° 32′ 36″ |
|---|---|---|---|---|---|---|---|
| Log. sin | 9. 83338 | + 1 | 9. 83339 | Log. sec | 10. 00132 | − 1 | 10. 00131 |
| Log. cos | 9. 86448 | − 1 | 9. 86447 | Log. cosec | 11. 10858 | +97 | 11. 10955 |
| Log. tan | 9. 96890 | + 3 | 9. 96893 | Log. cot | 11. 10726 | +98 | 11. 10824 |

It should be observed that, for uniformity and convenience, all logarithms given in Table 44 have been increased by 10 in the index, and it is understood that −10 ought properly to be written after each; thus all logarithms under 10.00000 represent functions whose value is less than unity, and all over 10.00000 those greater than unity; for example, 11.10726 is the logarithm of a number in which the decimal point should be placed after the second figure from the left.

*To find the angle corresponding to any logarithmic function*, the process is the reverse of the one just described. Find, in the column marked with the name of the function, either at top or bottom, the two logarithms between which the given one falls; write down the degrees and minutes of the lesser of the two corresponding angles, which will be the degrees and minutes of the angle required. Call the difference between the two tabulated logarithms D, and the difference between the given logarithm and that which corresponds to the lesser angle, $d$; then if $n$ represent the number of seconds, we have:

$$n = \frac{d}{D} \times 60.$$

Or, the same may be obtained by inspection (except where, as before explained, the differences for seconds are not tabulated) by finding, in the "Diff." column adjacent to that from which the logarithm was taken, the logarithmic difference, $d$, and noting the number of seconds abreast which it stands in the left-hand minute column.

Interpolation may be also made in the reverse direction from the next greater even minute.

Thus, if it be required to find the angle corresponding to log. sin 9.61400, we find log. sin 24° 16′, 9.61382, and log. sin 24° 17′, 9.61411; hence D = 29, and $d$ = 18;

$$n = \frac{18}{29} \times 60 = 37;$$

and the angle is 24° 16′ 37″. Or, in adjacent column headed "Diff.," 18 would be found abreast 38, 39, or 40 (seconds) in the left-hand minute column—a correspondence sufficiently close for navigation work.

If the angle were known to be in the second quadrant, we find log. sin 155° 43′, 9.61411, and log. sin 155° 44′, 9.61382; here, D = 29, and $d$ = 11;

$$n = \frac{11}{29} \times 60 = 23;$$

therefore, the angle is 155° 43′ 23″. Or, in adjacent "Diff." column find, abreast 11, 23 or 24 seconds.

| EXAMPLE I. | | EXAMPLE II. | |
|---|---|---|---|

Find angles less than 90° corresponding to log. cot 10.33621, log. sec 10.11579, and log. cos 8.70542.

Find angles in second quadrant corresponding to log. tan 10.15593, log. sin 8.87926, and log. cosec 10.04944.

| | | ° | ′ | $d$ | ″ | | | ° | ′ | $d$ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Log. cot | 10. 33621 | 24 | 45 | .8 | 15 | Log. tan | 10. 15593 | 124 | 55 | 19 | 42 |
| Log. sec | 10. 11579 | 40 | 00 | 4 | 22 | Log. sin | 8. 87926 | 175 | 39 | 69 | 25 |
| Log. cos | 8. 70542 | 87 | 05 | 116 | 28 | Log. cosec | 10. 04944 | 116 | 49 | 3 | 27 |

*The Hour Columns in Table 44* give the measure in time corresponding to twice the angular distance given in arc. Thus, abreast the angle 13° 00′ stands in the P. M. column 1ʰ 44ᵐ 00ˢ, corresponding in time to 2 × 13° 00′, and in the A. M. column 10ʰ 16ᵐ 00ˢ, which is the same subtracted from 12ʰ. These columns are of use in working the various formulæ which involve functions of half the hour angle. Interpolation for values intermediate to those given in the tables is made on the same principle as for the angular measure; this operation may be performed by inspection by the use of the small tables at the bottom of each page, where $n$, the number of seconds of time, is given in bold-faced type, and $d$, the logarithmic difference for the respective columns, appears below.

| EXAMPLE I. | | EXAMPLE II. | |
|---|---|---|---|

Given $t$=1ʰ 48ᵐ 44ˢ, find log. cot ½ $t$.

Given log. sin ½ $t$ 9.91394, find the Hour A. M. corresponding.

| For 1ʰ 48ᵐ 40ˢ, | log. cot ½ $t$ 10. 61687 | | For 9.91389, | 4ʰ 39ᵐ 12ˢ |
|---|---|---|---|---|
| Diff. for 4ˢ, Col B, | − 28 | | Diff. for 5, Col. C, | − 5 |
| For 1ʰ 48ᵐ 44ˢ, | log. cot ½ $t$ 10. 61659 | | For 9.91394. | 4 39 07 |

## MISCELLANEOUS USEFUL DATA.

Earth's Polar radius=6,356,583.8 meters.
Earth's Equatorial radius=6,378,206.4 meters.

Earth's Compression=$\dfrac{1}{293.465}$.

| | |
|---|---|
| Earth's Eccentricity=0.0824846 | log 8. 9163666. |
| Number of feet in one statute mile=5280 | log 3. 7226339. |
| Number of feet in one nautical mile=6080.27 | log 3. 7839229. |
| Sine of 1″=0.00000485 | log 4. 6855749. |
| Sine of 1′=0.00029089 | log 6. 4637261. |
| The Napierian base ε=2.7182818 | log 0. 4342945. |
| The modulus of common logarithms=0.4342945 | log 9. 6377843. |
| French meter in English feet, 3.2808333 | log 0. 5159842. |
| French meter in English statute miles, 0.000621369 | log 6. 7933496. |
| French meter in nautical miles, 0.000539593 | log 6. 7320663. |

1 pound Avoirdupois=7,000 grains Troy.
French gramme=0.00220606 Imperial pound Troy.
French kilogramme=0.0196969 English cwts.
Cubic inch of distilled water, in grains=252.458.
Cubic foot of water, in ounces Troy=908.8488.
Cubic foot of water, in pounds Troy=75.7374.                    }Bar. 30.00 in.; ther. 62° F.
Cubic foot of water, in ounces Avoirdupois=997.1366691.
Cubic foot of water, in pounds Avoirdupois=62.3210606.
Length of pendulum which vibrates second at Greenwich, 39.1393 inches.

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

The following table contains the latitude and longitude of a large number of places, together with lunitidal intervals and tidal ranges at the more important ones. It is arranged geographically and followed by an alphabetical index.

The geographical position generally relates to some specified exact location, and is based upon the best available authority. The tidal data relate to the waters adjacent to the point whose latitude and longitude are given, being abstracted from the Tide Tables published by the United States Coast and Geodetic Survey for the year 1903.

The high water and low water lunitidal intervals represent the mean intervals between the moon's transit and the time of next succeeding high and low waters throughout a lunar month. The spring and neap ranges are the differences in height between high water and low water at spring and at neap tides. For those places where the tide is chiefly of a diurnal type, and where there is usually but one high and one low water during a lunar day, the tidal values are bracketed; in such cases the lunitidal intervals are for the semi-diurnal part of the tide (which, however, is only appreciable for a few days when the moon is near the equator), and the range given in the column headed "Spg." does not, as in other cases, apply to the spring tide, but to the greatest periodic daily range, which usually occurs a day or two after the moon attains its extreme of declination, and is therefore near one of the tropics. As those places where the diurnal type predominates seldom experience large tidal effects, the general data furnished regarding such tides will suffice for the ordinary purpose of the navigator. The method of finding the time of high or low water from this table is illustrated in article 507, Chapter XX.

190

MARITIME POSITIONS AND TIDAL DATA.

**EAST COAST OF NORTH AMERICA.**

| Coast. | Place. | Lat. N. | Long. W | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Labrador. | Salisbury Island: E. pt | 63 27 00 | 76 30 00 | | | | |
| | Nottingham Island: S. pt | 63 06 00 | 77 50 00 | 8 58 | 2 46 | 13.5 | 6.1 |
| | Digges Island: W. extreme | 62 37 00 | 78 08 00 | | | | |
| | Cape Wostenholme | 62 35 00 | 77 33 00 | | | | |
| | Charles Island: E. pt | 62 48 00 | 74 00 00 | | | | |
| | W. pt | 62 50 00 | 75 20 00 | | | | |
| | Cape Weggs | 62 30 00 | 74 03 00 | | | | |
| | Prince of Wales Sound: Center of ent ... | 62 07 00 | 72 25 00 | | | | |
| | Cape of Hopes Advance | 61 18 00 | 70 02 00 | | | | |
| | Akpatok Island: E. pt | 60 10 00 | 67 05 00 | | | | |
| | Green Island: NE. pt | 60 40 00 | 67 50 00 | | | | |
| | Button Islands: N. pt | 60 52 00 | 64 40 00 | | | | |
| | Cape Chidleigh | 60 33 00 | 64 12 00 | | | | |
| | Resolution Island: S. pt., Hutton h'dl'd | 61 21 00 | 65 00 00 | | | | |
| | E. pt., C. Resolution | 61 40 00 | 64 30 00 | | | | |
| | Black Head | 60 00 00 | 64 28 00 | | | | |
| | Eclipse Harbor: E. side | 59 48 00 | 64 07 15 | 8 00 | 1 48 | 5.0 | 2.0 |
| | Nachvack Bay: Islands off entrance .... | 59 07 00 | 63 20 00 | 7 00 | 0 48 | 5.2 | 2.1 |
| | Saddle Island | 57 35 00 | 61 20 00 | | | | |
| | Port Manvers: Entrance | 57 00 00 | 62 07 00 | | | | |
| | Nain: Church | 56 32 45 | 61 40 13 | 7 00 | 0 48 | 6.5 | 3.0 |
| | Hopedale Harbor: Hill to E'd | 55 27 04 | 60 12 34 | 5 30 | 11 43 | 6.9 | 3.2 |
| | Aillick Harbor: Cape Mokkivik | 55 13 33 | 59 08 01 | | | | |
| | Cape Harrison: N. extreme | 54 55 50 | 57 56 40 | | | | |
| | Indian Harbor: Obs | 54 26 55 | 57 12 40 | 6 10 | 12 23 | 7.0 | 3.2 |
| | Outer Gannet Island: Summit | 54 00 05 | 56 31 31 | | | | |
| | Gready Harbor | 53 50 00 | 56 23 00 | | | | |
| | Cartwright Harbor: Caribou Castle | 53 42 37 | 56 59 50 | | | | |
| | Indian Tickle: Summit | 53 34 25 | 55 58 39 | 6 27 | 0 15 | 6.0 | 2.8 |
| | Roundhill Island: Summit | 53 26 00 | 55 35 48 | | | | |
| | Occasional Harbor: E. summit of Twin I. | 52 40 07 | 55 44 29 | 6 38 | 0 26 | 5.0 | 2.3 |
| | Cape St. Lewis: SE. pt | 52 21 16 | 55 38 08 | 6 30 | 0 18 | 3.5 | 1.6 |
| | Battle Islands: NE. extreme, SE. I | 52 15 36 | 55 32 20 | | | | |
| | Table Head | 52 06 00 | 55 41 00 | | | | |
| Newfoundland. | Belle Isle: Light-house | 51 53 00 | 55 22 10 | | | | |
| | Cape Bauld: Light-house | 51 38 48 | 55 25 12 | | | | |
| | Bell Island: S. end | 50 42 10 | 55 35 30 | | | | |
| | Cape St. John: Gull Island light | 49 59 54 | 55 21 33 | | | | |
| | Tilt Cove, Union Copper Mine | 49 53 00 | 55 37 17 | | | | |
| | Funk Island: Summit | 49 45 29 | 53 10 56 | | | | |
| | Offer Wadham: Light-house | 49 35 40 | 53 45 00 | | | | |
| | Toulinguet Islands: Light-house | 49 41 20 | 54 47 35 | | | | |
| | Seldom-come-by Harbor: Shiphill | 49 36 50 | 54 12 00 | | | | |
| | Cape Freels: Gull I | 49 15 20 | 53 25 12 | | | | |
| | Greenspond Island | 49 04 20 | 53 37 45 | | | | |
| | Cape Bonavista: Light-house | 48 42 01 | 53 04 42 | | | | |
| | Catalina Harbor: Green I. light-house .. | 48 30 15 | 53 02 40 | | | | |
| | Bonaventure Head | 48 16 55 | 53 23 35 | | | | |
| | Hearts Content: Light-house | 47 53 10 | 53 23 20 | 7 23 | 1 11 | 4.1 | 1.9 |
| | Baccalieu Island: Light-house | 48 08 58 | 52 47 42 | | | | |
| | Harbor Grace: Light-house on beach ... | 47 42 45 | 53 08 11 | 7 15 | 1 03 | 3.3 | 1.5 |
| | Cape St. Francis: Light-house | 47 48 30 | 52 47 20 | | | | |
| | St. Johns Harbor: Chain Rock Battery.. | 47 34 02 | 52 40 54 | 7 12 | 1 01 | 3.3 | 1.5 |
| | Cape Race: Light-house | 46 39 24 | 53 04 30 | 6 50 | 0 38 | 6.5 | 3.0 |
| | Cape Pine: Light-house | 46 37 04 | 53 31 55 | | | | |
| | Trepassey Harbor: Shingle Neck | 46 43 20 | 53 22 10 | 6 50 | 0 38 | 6.6 | 3.1 |
| | Cape St. Mary: Light-house | 46 49 34 | 54 11 42 | 8 20 | 2 08 | 7.2 | 3.3 |
| | Little Placentia Harbor: W. side Coopers Cove | 47 17 55 | 53 58 43 | | | | |
| | Burin Island: Light-house | 47 00 26 | 55 08 49 | | | | |
| | Laun: Gr. Laun R. C. Church | 46 56 30 | 55 32 00 | 8 05 | 1 53 | 7.0 | 3.2 |
| | St. Pierre: U. S. Coast Survey Station... | 46 46 51 | 56 10 36 | 8 23 | 2 11 | 6.6 | 3.1 |
| | Brunet Island: Mercers Hd. light-house. | 47 15 30 | 55 51 40 | 8 53 | 2 41 | 6.5 | 3.0 |
| | Boar Islands: Burgeo I. light-house | 47 35 13 | 57 36 52 | 8 22 | 2 10 | 6.2 | 2.9 |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Newfoundland.** | La Poile Bay: Gr. Espic Church......... | 47 39 50 | 58 24 10 | 8 50 | 2 38 | 6.0 | 2.8 |
| | Cape Ray: Light-house ................. | 47 37 00 | 59 18 00 | ...... | ...... | ...... | ...... |
| | Codroy Island: S. side Boat Harbor...... | 47 52 30 | 59 23 40 | 8 50 | 2 32 | 4.3 | 2.1 |
| | Cape St. George: Red I., SE. pt ......... | 48 33 48 | 59 13 10 | ...... | ...... | ...... | ...... |
| | Cow Head: NW. extreme................. | 49 55 20 | 57 50 00 | 9 40 | 3 13 | 4.9 | 2.5 |
| | Port Saunders: NE. point of entry...... | 50 38 30 | 57 17 07 | ...... | ...... | ...... | ...... |
| | Rich Point: Light-house ...... ........ | 50 41 39 | 57 24 20 | ...... | ...... | ...... | ...... |
| | Férolle Point: Cove Point, NE. extreme . | 51 02 10 | 57 02 40 | ...... | ...... | ...... | ...... |
| | Flower Cove: Capstan Pt ............... | 51 17 25 | 56 44 45 | ...... | ...... | ...... | ...... |
| | Green Island: 150 fms. from NE. end ... | 51 24 10 | 56 33 40 | ...... | ...... | ...... | ...... |
| | Cape Norman: Light-house ............. | 51 38 00 | 55 53 52 | ...... | ...... | ...... | ...... |
| **Labrador.** | Chateau Bay: S. pt. Castle I ............. | 51 58 00 | 55 50 20 | ...... | ...... | ...... | ...... |
| | Amour Point: Light-house ............. | 51 27 35 | 56 51 05 | ...... | ...... | ...... | ...... |
| | Wood Island: S. pt..................... | 51 22 45 | 57 08 00 | ...... | ...... | ...... | ...... |
| | Greenly Island: Light-house ........... | 51 22 35 | 57 10 50 | ...... | ...... | ...... | ...... |
| | Bradore Bay: Obs. Spot, Jones Pt ....... | 51 27 30 | 57 14 12 | ...... | ...... | ...... | ...... |
| | Old Fort Island: Center................. | 51 21 40 | 57 46 00 | ...... | ...... | ...... | ...... |
| | Great Mecatina: SE pt.................. | 50 47 30 | 58 51 00 | ...... | ...... | ...... | ...... |
| | Mecatina Harbor: S. point of Dead Cove. | 50 46 44 | 58 59 20 | ...... | ...... | ...... | ...... |
| | Little Mecatina I.: S. pt. C. McKinnon.. | 50 31 40 | 59 20 00 | ...... | ...... | ...... | ...... |
| | St. Mary Reefs ......................... | 50 14 00 | 59 45 00 | ...... | ...... | ...... | ...... |
| | South Makers Ledge..................... | 50 09 30 | 59 57 00 | ...... | ...... | ...... | ...... |
| **R. and G. of St. Lawrence.** | Cape Whittle.......................... | 50 11 00 | 60 08 00 | ...... | ...... | ...... | ...... |
| | Natashquan Point: S. edge.............. | 50 06 00 | 61 44 00 | 1 25 | 6 45 | 4.0 | 2.0 |
| | Clearwater Point: SW. extreme ......... | 50 12 27 | 63 27 03 | ...... | ...... | ...... | ...... |
| | Carousel Island: Light-house........... | 50 05 40 | 66 22 44 | 1 43 | 7 05 | 8.1 | 6.0 |
| | Point de Monts: Light-house........... | 49 19 35 | 67 21 55 | 1 48 | 7 18 | 10.8 | 8.0 |
| | Quebec: Mann's Bastion, Citadel........ | 46 48 17 | 71 12 19 | 6 07 | 0 54 | 14.6 | 10.8 |
| | Montreal: Cathedral.................... | 45 30 24 | 73 33 04 | ...... | ...... | ...... | ...... |
| | Father Point: Light-house ............. | 48 31 25 | 68 27 40 | 1 52 | 7 33 | 12.0 | 8.9 |
| | Cape Chatte: Extreme................... | 49 06 00 | 66 46 00 | 1 46 | 7 13 | 10.5 | 7.8 |
| | Cape Magdalen: Light-house........... | 49 15 40 | 65 19 30 | 1 33 | 6 50 | 6.4 | 4.7 |
| | Cape Rosier: Light-house .............. | 48 51 37 | 64 12 00 | 1 25 | 6 40 | 5.5 | 4.1 |
| | Cape Gaspé: Light-house............... | 48 45 15 | 64 09 35 | ...... | ...... | ...... | ...... |
| | Anticosti Island: Heath Pt. light-house . | 49 05 20 | 61 42 30 | 1 20 | 6 35 | 3.6 | 1.8 |
| | SW. pt. light-house ... | 49 23 45 | 63 35 46 | 1 25 | 6 40 | 4.9 | 2.5 |
| **New Brunswick.** | Bonaventure Island: E. pt ...'........ | 48 29 30 | 64 08 00 | ...... | ...... | ...... | ...... |
| | Leander Shoal......................... | 48 24 00 | 64 18 00 | ...... | ...... | ...... | ...... |
| | Macquereau Point ..................... | 48 12 00 | 64 46 30 | 1 55 | 7 33 | 4.7 | 2.3 |
| | Chaleur Bay: Carlisle.................. | 48 01 00 | 65 19 00 | 2 20 | 8 07 | 4.8 | 2.4 |
| | Dalhousie I ................ | 48 04 24 | 66 22 10 | 3 10 | 9 10 | 8.1 | 4.1 |
| | Miscou Island: NE. pt., Point Birch .... | 48 01 00 | 64 29 00 | 2 00 | 8 25 | 4.0 | 2.0 |
| | Miramichi Bay: Portage I., N. pt........ | 47 14 00 | 65 02 00 | 4 16 | 10 59 | 2.3 | 1.2 |
| | Point Escumenac: Light-house ......... | 47 05 00 | 64 47 33 | ...... | ...... | ...... | ...... |
| **P. Edward I.** | North Point: Light-house .............. | 47 03 46 | 63 59 19 | 4 20 | 11 00 | 2.4 | 1.2 |
| | Richmond Harbor: Royalty Pt.......... | 46 34 00 | 63 43 00 | 5 15 | 11 55 | 1.8 | 0.9 |
| | East Point: Light-house ............... | 46 27 15 | 61 58 05 | 8 17 | 2 20 | 1.4 | 0.7 |
| | Charlottetown: Flag-staff on fort ....... | 46 13 55 | 63 07 23 | 11 07 | 4 23 | 6.4 | 3.2 |
| **Magdalen Is.** | Gt. Bird Rock: Light-house ............. | 47 50 40 | 61 08 32 | ...... | ...... | ...... | ...... |
| | East Island: E. extreme ............... | 47 37 40 | 61 24 30 | ...... | ...... | ...... | ...... |
| | Entry Island: Light-house ............. | 47 16 30 | 61 41 20 | ...... | ...... | ...... | ...... |
| | Amherst Hbr.: N. side of entrance ..... | 47 14 23 | 61 49 38 | ...... | ...... | ...... | ...... |
| | Deadman Rock: W. pt.................. | 47 16 03 | 62 12 25 | ...... | ...... | ...... | ...... |
| | St. Paul Island: Light-house, NE. end.. | 47 13 50 | 60 08 32 | 8 30 | 2 12 | 2.7 | 1.4 |
| | Light-house, SW. end.. | 47 11 20 | 60 09 50 | ...... | ...... | ...... | ...... |
| **C. Breton I.** | Cape North: Light-house .............. | 47 01 45 | 60 23 27 | 8 35 | 2 17 | 3.1 | 1.6 |
| | St. Anns Harbor: E. pt. entrance....... | 46 21 00 | 60 27 00 | 8 25 | 2 13 | 6.0 | 3.7 |
| | Sydney Harbor: Light-house........... | 46 12 25 | 60 12 50 | 8 10 | 2 05 | 5.0 | 3.1 |

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| C. Breton I. | Scatary Island: Light-house, NE. pt .... | 46 02 15 | 59 40 25 | ....... | ....... | ...... | ...... |
| | Louisburg: Light-house, NE. pt ........ | 45 54 34 | 59 59 26 | 7 45 | 1 35 | 5.0 | 3.1 |
| | Madame Island: S. pt.................. | 45 28 00 | 61 03 00 | 7 55 | 1 47 | 5.0 | 3.1 |
| | Port Hood: Just-au-corps I ........... | 46 00 00 | 61 36 00 | 9 05 | 2 47 | 3.5 | 1.8 |
| | Sable Island: Light-house, E. end ...... | 43 58 14 | 59 46 08 | ....... | ....... | ...... | ...... |
| Nova Scotia. | Pictou: Custom-house .................. | 45 40 50 | 62 42 10 | 9 34 | 3 13 | 3.9 | 2.0 |
| | Cape St. George ...................... | 45 52 00 | 61 52 00 | 9 20 | 3 00 | 2.8 | 1.4 |
| | North Canso: Light-house, NW. entrance.. | 45 41 42 | 61 29 10 | 9 26 | 3 10 | 3.1 | 1.6 |
| | Arichat Harbor: R. C. Church steeple .. | 45 30 48 | 61 01 47 | 7 55 | 1 47 | 5.0 | 3.1 |
| | Cape Canso: Cranberry I., light-house .. | 45 19 49 | 60 55 41 | 7 43 | 1 36 | 6.5 | 4.0 |
| | White Head Island: Light-house ........ | 45 11 58 | 61 08 14 | 7 45 | 1 38 | 6.6 | 4.1 |
| | Green Island: Light-house ............. | 45 06 15 | 61 32 40 | ....... | ....... | ...... | ...... |
| | Wedge Island: Light-house ............ | 45 00 35 | 61 52 45 | ....... | ....... | ...... | ...... |
| | Halifax: Dock-yard observatory......... | 44 39 38 | 63 35 22 | 7 34 | 1 46 | 5.2 | 3.2 |
| | Sambro Island: Light-house............ | 44 26 10 | 63 33 30 | ....... | ....... | ...... | ...... |
| | Margaret Bay: Shut-in I .............. | 44 34 00 | 63 54 00 | 7 32 | 1 30 | 7.1 | 4.4 |
| | Tancook Island....................... | 44 29 00 | 64 06 00 | ....... | ....... | ...... | ...... |
| | Lunenburg: Battery Pt. light ......... | 44 21 45 | 64 17 35 | 7 39 | 1 36 | 7.0 | 4.3 |
| | Cape Le Havre: Black Rock ........... | 44 12 00 | 64 18 00 | ....... | ....... | ...... | ...... |
| | Coffin Island: Light-house ............ | 44 02 00 | 64 37 30 | ....... | ....... | ...... | ...... |
| | Little Hope Island: Light-house........ | 43 48 30 | 64 47 15 | ....... | ....... | ...... | ...... |
| | Shelburne Hbr.: Two lights, McNutts I. | 43 37 15 | 65 15 45 | ....... | ....... | ...... | ...... |
| | Cape Sable: Light-house .............. | 43 23 19 | 65 37 11 | 8 17 | 2 05 | 8.5 | 5.2 |
| | Seal Island: Light-house.............. | 43 23 34 | 66 00 52 | 9 35 | 3 23 | 12.8 | 9.5 |
| | Yarmouth: Cape Fourchu light ........ | 43 47 28 | 66 09 21 | 10 00 | 3 41 | 16.0 | 11.8 |
| | Cape St. Mary....................... | 44 05 20 | 66 12 40 | ....... | ....... | ...... | ...... |
| | Bryer Island: Light-house ............ | 44 14 57 | 66 23 38 | 10 29 | 4 36 | 20.8 | 15.4 |
| | Annapolis Harbor: Prim Pt. light ..... | 44 41 34 | 65 47 20 | 10 49 | 4 41 | 27.5 | 20.4 |
| | Haute Island: Light-house ............ | 45 14 55 | 65 00 45 | 11 07 | 5 27 | 33.0 | 24.4 |
| | Cape Chignecto....................... | 45 19 00 | 64 57 00 | ....... | ....... | ...... | ...... |
| | Burntcoat Head: Light-house ......... | 45 18 40 | 63 48 30 | 0 27 | 7 27 | 50.5 | 37.4 |
| New Brunswick. | Cape Enragé: Light-house ............. | 45 35 34 | 64 46 55 | ....... | ....... | ...... | ...... |
| | Cape Quaco: Light-house ............. | 45 19 30 | 65 32 00 | 11 21 | 5 56 | 30.0 | 22.2 |
| | St. Johns: Partridge I. light ......... | 45 14 20 | 66 03 20 | 11 07 | 4 58 | 23.9 | 17.7 |
| | Cape Lepreau: Light-house ........... | 45 03 40 | 66 27 40 | 11 04 | 5 26 | 24.5 | 18.2 |
| | L'Etang Harbor: S. pt. tower ........ | 45 04 00 | 66 49 00 | 11 09 | 5 08 | 23.3 | 17.1 |
| | St. Andrew: S. pt. light.............. | 45 04 06 | 67 02 52 | 11 00 | 5 00 | 24.9 | 18.2 |
| | Campo Bello Island: Light-house, N. pt. | 44 57 40 | 66 54 10 | ....... | ....... | ...... | ...... |
| | Grand Manan Island: Light-house, NE. pt. | 44 45 52 | 66 44 00 | 11 02 | 5 21 | 22.5 | 16.7 |
| | Gannet Rock: Light-house, NE. pt ..... | 44 30 38 | 66 47 00 | ....... | ....... | ...... | ...... |
| | Machias Island: Light-house ........... | 44 30 07 | 67 06 13 | 10 51 | 4 56 | 18.0 | 13.2 |
| Maine. | Calais: Astronomical station............ | 45 11 05 | 67 16 50 | 11 36 | 5 40 | 23.3 | 17.1 |
| | Eastport: Cong. Church............... | 44 54 15 | 66 59 14 | 11 09 | 5 05 | 20.9 | 15.2 |
| | Quoddy Head: Light-house ........... | 44 48 55 | 66 57 04 | ....... | ....... | ...... | ...... |
| | Machias: Town Hall.................. | 44 43 01 | 67 27 22 | 11 02 | 4 59 | 15.5 | 11.3 |
| | Petit Manan Island: Light-house ....... | 44 22 03 | 67 51 51 | ..?.. | ....... | ...... | ...... |
| | Bakers Island: Light-house ........... | 44 14 29 | 68 11 58 | ..?.. | ....... | ...... | ...... |
| | Mount Desert Rock: Light-house ....... | 43 58 08 | 68 07 44 | ....... | ....... | ...... | ...... |
| | Bangor: Thomas Hill ................. | 44 48 23 | 68 46 59 | 0 23 | 6 47 | 15.1 | 11.0 |
| | Belfast: Methodist Church ............ | 44 25 29 | 69 00 19 | 11 35 | 5 22 | 11.7 | 8.6 |
| | Rockland: Episcopal Church........... | 44 06 06 | 69 06 52 | 11 09 | 4 55 | 11.0 | 8.1 |
| | Matinicus Rock: Light-house........... | 43 47 03 | 68 51 28 | 10 45 | 4 31 | 10.2 | 7.5 |
| | Monhegan Island: Light-house ........ | 43 45 53 | 69 18 59 | ....... | ....... | ...... | ...... |
| | Seguin Island: Light-house ........... | 43 42 26 | 69 45 32 | ....... | ....... | ...... | ...... |
| | Bath: Winter St. Church ............. | 43 54 55 | 69 49 00 | 12 13 | 6 16 | 7.9 | 5.8 |
| | Brunswick: College spire.............. | 43 54 29 | 69 57 44 | ....... | ....... | ...... | ...... |
| | Augusta: Baptist Church.............. | 44 18 52 | 69 46 37 | 2 54 | 10 18 | 4.9 | 3.6 |
| | Portland: Custom-house .............. | 43 39 28 | 70 15 18 | 11 06 | 4 51 | 10.1 | 7.3 |
| | ___Portland Head light-house ... | 43 37 23 | 70 12 30 | ....... | ....... | ...... | ...... |
| | Cape Elizabeth: Light-house (west) .... | 43 33 51 | 70 12 11 | ....... | ....... | ...... | ...... |
| | Wood Island: Light-house ............ | 43 27 24 | 70 19 46 | 11 12 | 4 51 | 10.2 | 7.5 |
| | Boon Island: Light-house............. | 43 07 17 | 70 28 37 | ....... | ....... | ...... | ...... |

# APPENDIX IV.
## MARITIME POSITIONS AND TIDAL DATA.
### EAST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| N. H. | Whale Back: Light-house | 43 03 32 | 70 41 49 | ...... | ...... | ...... | ...... |
| | Portsmouth: Navy-yard flagstaff | 43 04 56 | 70 44 22 | 11 23 | 5 09 | 10.5 | 7.7 |
| | Fort Constitution | 43 04 16 | 70 42 34 | ...... | ...... | ...... | ...... |
| | Hampton: Baptist Church | 42 56 15 | 70 50 12 | ...... | ...... | ...... | ...... |
| | Isles of Shoals: White I. light-house | 42 58 02 | 70 37 25 | 11 19 | 4 58 | 10.0 | 7.3 |
| Massachusetts. | Newburyport: Academy | 42 48 30 | 70 52 28 | 11 23 | 5 10 | 9.1 | 6.6 |
| | Plum I. light-house | 42 48 55 | 70 49 10 | | | | |
| | Ipswich: Light-house (rear) | 42 41 07 | 70 46 00 | 11 17 | 5 04 | 10.1 | 7.4 |
| | Annisquam Harbor: Light-house | 42 39 43 | 70 40 55 | 11 13 | 5 00 | 10.1 | 7.4 |
| | Cape Ann: Thatchers I. light-house (N.) | 42 38 21 | 70 34 31 | ...... | ...... | ...... | ...... |
| | Gloucester: Universalist Church | 42 36 46 | 70 39 59 | | | | |
| | Ten-pound I. light-house | 42 36 07 | 70 39 58 | 11 02 | 4 49 | 10.2 | 7.5 |
| | Beverly: Hospital Pt. light-house | 42 32 48 | 70 51 23 | ...... | ...... | ...... | ...... |
| | Salem: Derbys Wharf light-house | 42 31 00 | 70 53 03 | 11 16 | 5 03 | 10.6 | 7.7 |
| | Marblehead: Light-house | 42 30 20 | 70 50 03 | 11 09 | 4 57 | 10.6 | 7.7 |
| | Cambridge: Harvard Observatory | 42 22 48 | 71 07 43 | | | | |
| | Boston: Navy-yard flagstaff | 42 22 22 | 71 03 05 | 11 27 | 5 17 | 11.0 | 8.1 |
| | State house | 42 21 28 | 71 03 50 | ...... | ...... | ...... | ...... |
| | Little Brewster I. light-house | 42 19 41 | 70 53 26 | 11 09 | 4 56 | 10.9 | 8.0 |
| | Minots Ledge: Light-house | 42 16 11 | 70 45 35 | ...... | ...... | ...... | ...... |
| | Plymouth: Pier head | 41 58 44 | 70 39 12 | ...... | ...... | ...... | ...... |
| | Gurnet light-house | 42 00 12 | 70 36 04 | 11 23 | 5 11 | 10.8 | 7.9 |
| | Barnstable: Light-house | 41 43 20 | 70 16 52 | 11 36 | 5 25 | 11.6 | 8.5 |
| | Cape Cod: Highlands light-house | 42 02 23 | 70 03 40 | ...... | ...... | ...... | ...... |
| | Chatham: Light-house (south) | 41 40 17 | 69 57 01 | 12 11 | 5 57 | 4.6 | 3.4 |
| | Monomoy Point: Light-house | 41 33 34 | 69 59 39 | 12 00 | 5 48 | 4.3 | 3.1 |
| | Nantucket: South Church | 41 16 55 | 70 05 57 | 0 04 | 6 00 | 3.8 | 2.3 |
| | Nantucket South shoal: Light ship | 40 37 05 | 69 36 33 | ...... | ...... | ...... | ...... |
| | Sankaty Head: Light-house | 41 17 01 | 69 57 57 | ...... | ...... | ...... | ...... |
| | Tarpaulin Cove: Light-house | 41 28 08 | 70 45 29 | 7 51 | 1 51 | 2.8 | 1.7 |
| | Vineyard Haven: W. Chop light-house | 41 28 51 | 70 36 01 | 11 34 | 4 33 | 2.0 | 1.2 |
| | Gay Head: Light-house | 41 20 55 | 70 50 08 | 7 31 | 1 20 | 3.7 | 2.2 |
| | Cuttyhunk: Light-house | 41 24 52 | 70 57 01 | 7 36 | 0 59 | 4.3 | 2.6 |
| | New Bedford: Baptist Church | 41 38 10 | 70 55 36 | 7 57 | 1 18 | 5.2 | 3.1 |
| Rhode Island. | Sakonnet Point: Light-house | 41 26 30 | 71 13 30 | 7 40 | 1 05 | 4.5 | 2.6 |
| | Beaver Tail: Light-house | 41 26 58 | 71 24 00 | 7 40 | 1 09 | 4.7 | 2.8 |
| | Newport: Flagstaff, torpedo station | 41 29 07 | 71 19 40 | 7 48 | 1 00 | 4.4 | 2.6 |
| | Bristol Ferry: Light-house | 41 38 34 | 71 15 39 | 7 53 | 0 40 | 5.2 | 3.6 |
| | Providence: Unitarian Church | 41 49 26 | 71 24 19 | 8 12 | 0 57 | 5.4 | 3.4 |
| | Point Judith: Light-house | 41 21 40 | 71 28 55 | 7 32 | 1 17 | 3.8 | 2.3 |
| | Block Island: Light-house (SE) | 41 09 10 | 71 33 08 | 7 33 | 1 25 | 3.7 | 2.2 |
| | Watch Hill Point: Light-house | 41 18 14 | 71 51 32 | 8 49 | 2 38 | 3.2 | 2.1 |
| Connecticut and New York. | Montauk Point: Light-house | 41 04 16 | 71 51 27 | 8 20 | 2 03 | 2.3 | 1.5 |
| | Stonington: Light-house | 41 19 31 | 71 54 49 | 9 09 | 3 03 | 3.2 | 2.1 |
| | New London: Groton Monument | 41 21 16 | 72 04 47 | 9 26 | 3 32 | 2.9 | 1.9 |
| | Little Gull Island: Light-house | 41 12 23 | 72 06 26 | 9 26 | 3 04 | 3.0 | 2.0 |
| | Gardners Island: Light-house, N. pt | 41 08 29 | 72 08 44 | 9 40 | 3 35 | 2.5 | 1.7 |
| | Plum Island: Light-house, W. pt | 41 10 25 | 72 12 43 | ...... | ...... | ...... | ...... |
| | Saybrook: Light-house, Lynde Pt | 41 16 17 | 72 20 37 | 10 29 | 4 11 | 4.3 | 2.8 |
| | New Haven: Yale College spire (middle) | 41 18 28 | 72 55 45 | 11 08 | 4 54 | 7.0 | 4.9 |
| | Bridgeport Harbor: Light-house | 41 09 24 | 73 10 49 | 11 09 | 5 04 | 8.4 | 5.9 |
| | Norwalk Island: Light-house | 41 02 56 | 73 25 11 | 11 03 | 4 56 | 8.2 | 5.7 |
| | Shinnecock Bay: Light-house | 40 51 03 | 72 30 16 | 7 48 | 1 38 | 3.0 | 2.0 |
| | Fire Island: Light-house | 40 37 57 | 73 13 08 | 7 19 | 1 20 | 2.2 | 1.4 |
| | Albany: Dudley Observatory | 42 39 50 | 73 44 56 | 5 13 | 0 46 | 2.8 | 1.8 |
| | New York: Navy-yard flagstaff | 40 42 02 | 73 58 51 | 8 44 | 2 49 | 5.3 | 3.4 |
| | City Hall | 40 42 44 | 74 00 24 | ...... | ...... | ...... | ...... |
| | Fort Wadsworth: Light-house | 40 36 20 | 74 03 15 | 7 41 | 1 38 | 5.4 | 3.5 |

MARITIME POSITIONS AND TIDAL DATA.

**EAST COAST OF NORTH AMERICA—Continued.**

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H.W. | Lun. Int. L.W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| New Jersey, Delaware, Virginia, and Maryland. | Sandy Hook: Light-house (rear) | 40 27 42 | 74 00 09 | 7 30 | 1 23 | 5.6 | 3.6 |
| | Light-ship | 40 28 15 | 73 50 09 | ...... | ...... | ...... | ...... |
| | Navesink Highlands: N. light-house | 40 23 48 | 73 59 10 | ...... | ...... | ...... | ...... |
| | Barnegat Inlet: Light-house | 39 45 52 | 74 06 24 | 7 50 | 1 43 | 2.7 | 1.7 |
| | Tuckers Beach: Light-house | 39 30 22 | 74 17 08 | 7 48 | 1 42 | 4.2 | 2.7 |
| | Absecon Inlet: Light-house | 39 21 59 | 74 24 52 | 9 59 | 3 57 | 4.7 | 3.0 |
| | Five Fathom Bank: Light-ship | 38 47 20 | 74 34 36 | ...... | ...... | ...... | ...... |
| | Cape May: Light-house | 38 55 59 | 74 57 39 | 8 16 | 1 47 | 5.6 | 3.6 |
| | Philadelphia, Pa.: Statehouse | 39 56 53 | 75 09 03 | 1 28 | 8 58 | 6.2 | 4.4 |
| | Navy-yard flagstaff, League I | 39 53 14 | 75 10 32 | 0 53 | 8 02 | 7.0 | 5.2 |
| | Wilmington, Del.: Town hall | 39 44 27 | 75 33 03 | 12 00 | 6 40 | 6.7 | 4.9 |
| | Cape Henlopen: Light-house | 38 46 42 | 75 05 03 | 8 17 | 1 50 | 5.4 | 3.5 |
| | Assateague Island: Light-house | 37 54 40 | 75 21 23 | ...... | ...... | ...... | ...... |
| | Hog Island: Light-house | 37 23 46 | 75 41 59 | ...... | ...... | ...... | ...... |
| | Cape Charles: Light-house | 37 07 22 | 75 54 24 | 8 03 | 2 19 | 3.0 | 2.0 |
| | Baltimore: Washington Monument | 39 17 48 | 76 36 59 | 6 34 | 0 44 | 1.4 | 1.0 |
| | Annapolis: Naval Academy observatory | 38 58 53 | 76 29 08 | 4 39 | 10 53 | 1.0 | 0.8 |
| | Point Lookout: Light-house | 38 02 19 | 76 19 20 | 0 31 | 6 52 | 1.7 | 1.1 |
| | Washington, D. C.: Navy-yard flagstaff | 38 52 30 | 76 59 45 | 7 42 | 1 56 | 3.5 | 2.5 |
| | Naval Observatory | 38 55 14 | 77 03 57 | ...... | ...... | ...... | ...... |
| | Capitol dome | 38 53 20 | 77 00 36 | ...... | ...... | ...... | ...... |
| | Old Point Comfort: Light-house | 37 00 06 | 76 18 24 | 8 44 | 2 17 | 3.0 | 2.0 |
| | Norfolk: Navy-yard flagstaff | 36 49 33 | 76 17 46 | 9 05 | 2 47 | 3.2 | 2.1 |
| | Richmond, Va.: Capitol | 37 32 16 | 77 26 04 | 4 30 | 11 55 | 4.3 | 2.8 |
| | Cape Henry: Light-house | 36 55 35 | 76 00 27 | 7 53 | 1 43 | 3.2 | 2.1 |
| North Carolina. | Elizabeth City: Court-house | 36 17 58 | 76 13 23 | ...... | ...... | ...... | ...... |
| | Edenton: Court-house | 36 03 24 | 76 36 31 | ...... | ...... | ...... | ...... |
| | Currituck Beach: Light-house | 36 22 36 | 75 49 51 | 7 37 | 1 26 | 3.4 | 2.2 |
| | Bodie Island: Light-house | 35 49 07 | 75 33 49 | ...... | ...... | ...... | ...... |
| | Cape Hatteras: Light-house | 35 15 17 | 75 31 16 | ...... | ...... | ...... | ...... |
| | Ocracoke: Light-house | 35 06 32 | 75 59 11 | 7 00 | 0 45 | 2.2 | 1.5 |
| | Newbern, Episcopal spire | 35 06 21 | 77 02 24 | ...... | ...... | ...... | ...... |
| | Cape Lookout: Light-house | 34 37 22 | 76 31 29 | 6 29 | 0 20 | 4.4 | 3.0 |
| | Beaufort, N. C.: Court-house | 34 43 05 | 76 39 48 | 7 21 | 1 08 | 3.3 | 2.3 |
| | Frying-Pan Shoals: Light-ship | 33 34 26 | 77 49 12 | ...... | ...... | ...... | ...... |
| S. Carolina. | Georgetown: Episcopal Church | 33 22 08 | 79 16 49 | 8 39 | 3 38 | 4.3 | 2.9 |
| | Light-house, North I | 33 13 21 | 79 10 55 | ...... | ...... | ...... | ...... |
| | Cape Romain: Light-house | 33 01 06 | 79 22 19 | 6 59 | 0 50 | 5.9 | 4.1 |
| | Charleston: Light-house, Morris I | 32 41 43 | 79 52 54 | ...... | ...... | ...... | ...... |
| | St. Michael's Church | 32 46 34 | 79 55 49 | 7 20 | 1 10 | 6.0 | 4.2 |
| | Beaufort, S. C.: Episcopal Church | 32 26 02 | 80 40 27 | 8 10 | 2 06 | 8.5 | 5.9 |
| | Port Royal: Martins Industry light-ship | 32 05 33 | 80 33 15 | ...... | ...... | ...... | ...... |
| Georgia. | Tybee Island: Light-house | 32 01 20 | 80 50 37 | 7 10 | 1 04 | 7.9 | 5.5 |
| | Savannah: Exchange spire | 32 04 52 | 81 05 26 | 8 13 | 3 07 | 7.6 | 5.3 |
| | Sapelo Island: Light-house | 31 23 28 | 81 17 01 | 7 30 | 1 24 | 8.4 | 5.8 |
| | Darien: Winnowing House | 31 21 54 | 81 25 39 | 7 40 | 1 44 | 7.5 | 5.2 |
| | St. Simon: Light-house | 31 08 02 | 81 23 30 | 7 30 | 1 27 | 7.5 | 5.3 |
| | Brunswick: Academy | 31 08 51 | 81 29 26 | 8 00 | 1 57 | 7.8 | 5.4 |
| Florida. | Amelia Island: Light-house | 30 40 23 | 81 26 26 | ...... | ...... | ...... | ...... |
| | Fernandina: Astronomical station | 30 40 18 | 81 27 47 | 7 39 | 1 31 | 6.9 | 4.8 |
| | St. Johns River: Light-house | 30 23 36 | 81 25 27 | 7 36 | 1 33 | 5.4 | 3.7 |
| | Jacksonville: Methodist Church | 30 19 43 | 81 39 14 | ...... | ...... | ...... | ...... |
| | St. Augustine: Presbyterian Church | 29 53 20 | 81 18 41 | ...... | ...... | ...... | ...... |
| | Light-house | 29 53 07 | 81 17 12 | 8 12 | 2 00 | 5.3 | 3.6 |
| | Cape Canaveral: Light-house | 28 27 37 | 80 32 30 | 8 00 | 1 52 | 5.9 | 4.0 |
| | Jupiter Inlet: Light-house | 26 56 54 | 80 04 48 | 8 00 | 2 00 | 1.8 | 1.2 |
| | Fowey Rocks: Light-house | 25 35 25 | 80 05 41 | 8 20 | 2 16 | 2.6 | 1.3 |
| | Carysfort Reef: Light-house | 25 13 17 | 80 12 40 | 8 21 | 2 08 | 2.7 | 1.4 |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Florida.** | Alligator Reef: Light-house | 24 51 02 | 80 37 08 | 8 22 | 2 00 | 2.6 | 1.3 |
| | Sombrero Key: Light-house | 24 37 36 | 81 06 40 | 8 24 | 2 05 | 1.9 | 1.0 |
| | Sand Key: Light-house | 24 27 10 | 81 52 40 | 8 40 | 2 20 | 1.5 | 0.8 |
| | Key West: Light-house | 24 32 58 | 81 48 04 | 9 20 | 2 36 | 1.6 | 0.9 |
| | Loggerhead Key: Light-house | 24 38 04 | 82 55 42 | 9 44 | 3 21 | 1.4 | 0.8 |
| | Sanibel Island: Light-house | 26 27 11 | 82 00 43 | 12 17 | 6 10 | 2.3 | 1.2 |
| | Gasparilla Island: Light-house | 26 43 06 | 82 15 34 | 0 42 | 6 19 | 1.4 | 0.7 |
| | Tampa Bay: Egmont Key light | 27 36 04 | 82 45 40 | 11 32 | 5 07 | 1.8 | 0.9 |
| | Cedar Keys: Ast. station, Depot Key | 29 07 29 | 83 01 57 | 0 42 | 7 13 | 3.1 | 1.5 |
| | Seahorse Key light | 29 05 49 | 83 03 58 | ........ | ........ | | |
| | St. Marks: Fort St. Marks | 30 09 03 | 84 12 42 | 2 00 | 8 30 | 2.6 | 1.2 |
| | Apalachicola: Flag-staff | 29 43 32 | 84 59 12 | [12 10] | [5 35] | [2.5] | ...... |
| | Cape St. George: Light-house | 29 35 18 | 85 02 54 | ........ | ........ | | |
| | Cape San Blas: Light-house | 29 40 00 | 85 21 30 | [11 10] | [4 55] | [2.1] | ...... |
| | Pensacola: Light-house | 30 20 47 | 87 18 32 | ........ | ........ | | |
| | Navy-yard chimney | 30 20 49 | 87 16 06 | [11 28] | [4 20] | [1.7] | ...... |
| **Alabama, Mississippi, and Louisiana.** | Sand Island: Light-house (front) | 30 11 19 | 88 03 02 | . | | | |
| | Mobile Point: Light-house | 30 13 44 | 88 01 26 | [11 25] | [3 09] | [1.5] | ...... |
| | Mobile: Episcopal Church | 30 41 26 | 88 02 28 | [1 35] | [6 50] | [2.1] | ...... |
| | Horn Island: Light-house | 30 13 23 | 88 31 39 | [12 00] | [5 40] | [2.0] | ...... |
| | East Pascagoula: Coast-Survey station | 30 20 42 | 88 32 45 | [0 20] | [5 45] | [2.3] | ...... |
| | Mississippi City: Coast-Survey station | 30 22 54 | 89 01 57 | ........ | ........ | | |
| | Ship Island: Light-house | 30 12 53 | 88 57 56 | ........ | ........ | | |
| | Cat Island: Light-house | 30 13 57 | 89 09 41 | [0 23] | [6 35] | [2.1] | ...... |
| | Chandeleur: Light-house | 30 02 58 | 88 52 19 | [11 53] | [5 33] | [1.8] | ...... |
| | Mouth Mississippi River: Pass a l'Outre light | 29 11 30 | 89 02 28 | [11 15] | [5 00] | [1.6] | ...... |
| | S. Pass light (East Jetty) | 28 59 28 | 89 08 08 | [10 55] | [4 42] | [1.7] | ...... |
| | SW. Pass light | 28 58 22 | 89 23 30 | [10 54] | [4 41] | [1.9] | ...... |
| | New Orleans: United States Mint | 29 57 46 | 90 03 28 | ........ | ........ | | |
| | Barataria Bay: Light-house | 29 16 30 | 89 56 43 | [11 00] | [4 47] | [2.1] | ...... |
| | Timbalier Island: Light-house | 29 02 49 | 90 21 25 | [11 50] | [5 38] | [2.0] | ...... |
| | Ship Shoal: Light-house | 28 54 56 | 91 04 15 | [0 18] | [6 33] | [2.2] | ...... |
| | Southwest Reef: Light-house | 29 23 36 | 91 30 14 | [0 40] | [6 56] | [2.0] | ...... |
| | Calcasieu Pass: Light-house | 29 46 55 | 93 20 43 | 2 17 | 8 41 | 1.7 | 1.3 |
| | Sabine Pass: Light-house | 29 43 04 | 93 51 00 | 3 17 | 9 36 | 0.9 | 0.6 |
| **Texas.** | Galveston: Cathedral, N. spire | 29 18 17 | 94 47 26 | [4 18] | [10 33] | [1.4] | ...... |
| | Light-house, Bolivar Pt | 29 22 05 | 94 46 00 | [4 07] | [10 23] | [1.6] | ...... |
| | Matagorda: Coast-Survey station | 28 41 29 | 95 57 26 | ........ | ........ | | |
| | Light-house | 28 20 18 | 96 25 28 | [4 35] | [10 47] | [1.6] | ...... |
| | Indianola: Coast-Survey station | 28 32 28 | 96 31 01 | ........ | ........ | | |
| | Lavaca: Coast-Survey station | 28 37 36 | 96 37 21 | ........ | ........ | | |
| | Aransas Pass: Light-house | 27 51 53 | 97 03 23 | [4 25] | [10 35] | [1.6] | ...... |
| | Brazos Santiago: Light, S. end Padre I. | 26 04 16 | 97 10 00 | ........ | ........ | | |
| | Point Isabel: Light-house | 26 04 36 | 97 12 28 | ........ | ........ | | |
| | Rio Grande del Norte: Obs. N. side of entrance | 25 57 22 | 97 08 57 | [1 55] | [8 03] | [1.4] | ...... |
| **Mexico.** | San Fernando River: Entrance | 25 23 40 | 97 21 25 | ........ | ........ | | |
| | Santander River: Entrance | 23 46 20 | 97 46 55 | ........ | ........ | | |
| | Mount Mecate: Summit | 22 38 40 | 98 04 55 | ........ | ........ | | |
| | Tampico: Light-house | 22 15 50 | 97 49 55 | [1 06] | [7 19] | [1.3] | ...... |
| | Cape Roxo | 21 35 00 | 97 22 00 | ........ | ........ | | |
| | Lobos Cay: Light-house | 21 28 12 | 97 13 00 | ........ | ........ | | |
| | Tuspan Reefs: Middle islet | 21 03 00 | 97 13 35 | ........ | ........ | | |
| | Mexico: National Observatory | 19 26 01 | 99 06 39 | ........ | ........ | | |
| | Bernal Chico: Middle of islet | 19 39 50 | 96 24 39 | ........ | ........ | | |
| | Zempoala Point: Extreme | 19 27 26 | 96 20 22 | ........ | ........ | | |
| | Vera Cruz: San Juan d'Ulloa light | 19 12 29 | 96 07 57 | [2 49] | [8 38] | [2.4] | ...... |
| | Sacrificios Island | 19 10 10 | 96 05 30 | ........ | ........ | | |
| | Orizaba Mountain: 17,400 feet | 19 04 00 | 97 15 55 | ........ | ........ | | |
| | Cofre de Perote Mount: 14,000 feet | 19 29 30 | 97 07 30 | ........ | ........ | | |
| | Alvarado: E. side of entrance | 18 49 00 | 95 44 48 | ........ | ........ | | |
| | Roca Partida: Summit | 18 44 00 | 95 11 14 | ........ | ........ | | |
| | Tuxtla, volcano: Summit | 18 29 00 | 95 08 00 | ........ | ........ | | |
| | Montepio: Landing place | 18 40 00 | 95 05 12 | ........ | ........ | | |

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Mexico.** | Zapotitlan Point: Light-house | 18 34 00 | 94 50 00 | | | | |
| | San Juan Point: Light-house | 18 19 45 | 94 38 57 | | | | |
| | Coatzacoalcos: Light-house | 18 08 56 | 94 24 46 | | | | |
| | Santa Ana Lagoon: Entrance | 18 18 49 | 93 51 53 | | | | |
| | Tupilco River: Entrance | 18 26 44 | 93 25 25 | | | | |
| | Tabasco River: Light-house | 18 39 30 | 92 42 00 | | | | |
| | Carmen Island: NE. pt | 18 47 08 | 91 30 50 | | | | |
| | Laguna de Terminos: Vigia tower, W. end Carmen I | 18 38 44 | 91 50 17 | [12 16] | [6 00] | [1.6] | |
| **Yucatan.** | Paypoton Mount: Summit | 19 38 00 | 90 43 27 | | | | |
| | Lerma: Church | 19 48 24 | 90 36 11 | | | | |
| | Campeche: Light-house | 19 50 20 | 90 32 20 | 2 59 | 9 28 | 2.1 | 1.3 |
| | Fort San José | 19 51 36 | 90 30 51 | | | | |
| | Point Palmas | 21 02 00 | 90 22 00 | | | | |
| | Sisal: Fort light | 21 10 06 | 90 02 37 | 10 20 | 4 10 | 1.8 | 0.9 |
| | Madagascar Reef: Center | 21 26 30 | 90 18 27 | | | | |
| | Progreso: Light-house | 21 17 00 | 89 39 30 | | | | |
| | Silan: Village | 21 23 00 | 88 54 27 | | | | |
| | Lagartos: Village | 21 36 30 | 88 10 27 | | | | |
| | Cape Catoche: Light-house | 21 35 50 | 87 04 10 | 9 30 | 3 19 | 1.5 | 0.8 |
| | Arcas Cays: Light-house | 20 12 45 | 91 57 45 | [12 06] | [5 50] | [1.6] | |
| | Obispo Shoal: 16-foot spot | 20 29 00 | 92 13 27 | | | | |
| | New Bank: Center | 20 32 00 | 91 52 27 | | | | |
| | Triangles, E. reef: Beacon | 20 54 54 | 92 12 47 | [12 00] | [5 45] | [1.6] | |
| | Triangles, W. reef: Cay at SW. end | 20 58 00 | 92 18 57 | | | | |
| | Bajo Nuevo Reef: Center | 21 50 00 | 92 04 26 | | | | |
| | Arenas Cays: NW. Cay | 22 07 10 | 91 24 21 | | | | |
| | Alacran Reef: Perez Cay | 22 23 36 | 89 41 45 | | | | |
| | Contoy Island: Light-house | 21 33 00 | 86 48 00 | | | | |
| | Mugeres Island: Light-house | 21 12 00 | 86 43 39 | 9 20 | 3 08 | 1.6 | 0.9 |
| | Cancun Island: Nisuc Pt | 21 03 00 | 86 46 45 | | | | |
| | Cozumel Island: N. pt. light-house | 20 35 50 | 86 43 55 | 8 20 | 2 08 | 1.5 | 0.8 |
| | S. pt. light-house | 20 16 20 | 86 59 04 | | | | |
| | Ascension Bay: Allen Pt | 19 46 55 | 87 28 27 | | | | |
| | Chinchorro Bank: Cayo Lobos light | 18 23 20 | 87 23 40 | | | | |
| **Belize.** | Half-Moon Cay: Light-house | 17 12 15 | 87 32 30 | | | | |
| | Mauger Cay, NW. end: Light-house | 17 36 15 | 87 46 30 | | | | |
| | Glover Reef: SW. Cay | 16 42 20 | 87 50 50 | | | | |
| | English Cay: Light-house | 17 19 30 | 88 03 20 | | | | |
| | St. Georges Cay: Center | 17 33 15 | 88 04 45 | | | | |
| | Sand-Fly Cays: Hut, S. end | 16 57 50 | 88 06 05 | | | | |
| | South Water Cay: Center | 16 48 50 | 88 05 36 | | | | |
| | Belize: Fort George light | 17 29 20 | 88 11 20 | 8 00 | 1 50 | 1.5 | 0.8 |
| | North Standing Creek: Entrance | 16 57 40 | 88 13 48 | | | | |
| | Sittee Point: Cay | 16 47 45 | 88 15 15 | | | | |
| | Cockscomb Mount: Summit, 4,000 feet | 16 48 10 | 88 37 40 | | | | |
| | Placentia Point: Huts on point | 16 30 54 | 88 22 13 | | | | |
| | Icacos Point: S. extreme | 16 14 15 | 88 35 51 | | | | |
| | Sarstoon River: Entrance | 15 54 00 | 88 56 20 | | | | |
| **Guat.** | Dulce River: Entrance, W. side | 15 49 45 | 88 46 22 | 9 00 | 2 50 | 2.0 | 1.1 |
| | Dulce Gulf: Fort St. Philip | 15 38 00 | 89 01 36 | | | | |
| | Isabel | 15 24 20 | 89 09 44 | | | | |
| **Honduras.** | Hospital Bight: Hut, N. pt. of entrance | 15 52 20 | 88 33 22 | | | | |
| | Cape Three Points: NW. extreme | 15 57 45 | 88 38 50 | | | | |
| | Seal Cays: S. Cay | 16 08 00 | 88 20 15 | | | | |
| | Omoa: Entrance | 15 47 11 | 88 04 31 | | | | |
| | Cape Triunfo: Bluff pt | 15 48 45 | 87 27 46 | | | | |
| | Congrehoy Peak: Summit, 8,040 feet | 15 38 00 | 86 55 00 | | | | |
| | Truxillo: Fort | 15 55 45 | 85 59 18 | | | | |
| | Utilla Island: S. Cay | 16 03 40 | 86 59 15 | | | | |
| | Hog Islands: Highest hill on W. islet | 15 58 00 | 86 32 09 | | | | |
| | Roatan: Center of Coxen Cay | 16 18 00 | 86 34 27 | 7 35 | 1 23 | 3.5 | 1.8 |
| | Port Royal, NW. pt. of George Cay | 16 24 20 | 86 18 41 | | | | |
| | Bonacca Island: Summit, 1,200 feet | 16 28 00 | 85 55 00 | 8 50 | 2 38 | 1.5 | 0.8 |
| | Misteriosa Bank: S. Point | 18 44 00 | 84 02 00 | | | | |
| | Swan Islands: NW. pt. of W. I | 17 24 30 | 83 56 27 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Hondu-ras. | Great Rock Head: Bluff extreme........ | 15 53 00 | 85 27 10 | | | | |
| | Cape Camaron.................... | 16 00 00 | 85 03 00 | | | | |
| | Brewers Lagoon: E. side of entrance.... | 15 51 50 | 84 38 33 | | | | |
| | Patook River: E. side of entrance ...... | 15 48 50 | 84 17 10 | | | | |
| | Carataska Lagoon: E. side of entrance .. | 15 23 40 | 83 42 36 | | | | |
| Nicaragua. | Cape Gracias-á-Dios: Light-house........ | 15 00 00 | 83 10 00 | 10 20 | 4 07 | 2.0 | 1.1 |
| | Caxones Reef: Great Hobby Islet ...... | 16 03 30 | 83 08 20 | | | | |
| | Gorda Bank: Gorda Cay ............. | 15 52 00 | 82 23 27 | | | | |
| | Farrall Rock: Center ................. | 15 51 00 | 82 18 07 | | | | |
| | Half-Moon Cay: Center............. | 15 08 50 | 82 42 08 | | | | |
| | Alargate Reef: E. pt................. | 15 07 00 | 82 20 00 | | | | |
| Mosquito Coast. | Mosquito Cays: S. end............... | 14 21 12 | 82 45 57 | | | | |
| | Rosalind Bank: NW. extreme.......... | 16 54 00 | 80 51 27 | | | | |
| | Serranilla Bank: Beacon Cay........... | 15 47 45 | 79 50 53 | 4 00 | 10 13 | 2.0 | 1.1 |
| | Serrana Bank: Little Cay ............. | 14 21 33 | 80 15 20 | 4 00 | 10 13 | 2.0 | 1.1 |
| | Quita Sueño Bank: S. extreme of reef... | 14 08 00 | 81 08 21 | | | | |
| | Spit at NW. end.... | 14 30 00 | 81 07 21 | | | | |
| | Roncador Cay: S. pt.................. | 13 34 30 | 80 05 05 | | | | |
| | Old Providence: Isabel House.......... | 13 22 54 | 81 21 26 | 4 00 | 10 13 | 1.0 | 0.5 |
| | St. Andrews Island: SW. cove, Entrance I. | 12 31 40 | 81 43 06 | | | | |
| | Courtown Cays: Middle Cay .......... | 12 24 00 | 81 27 53 | | | | |
| | Albuquerque Bank: Smith Cay.......... | 12 10 00 | 81 49 54 | | | | |
| | Brangmans Bluff: Extreme ........... | 14 03 00 | 83 21 27 | | | | |
| | Pearl Cays: Colombilla Cay .......... | 12 22 35 | 83 23 10 | 1 50 | 8 03 | 2.0 | 1.1 |
| | Pearl Cays Lagoon: Mosquito Pt ....... | 12 20 39 | 83 37 12 | | | | |
| | Cookra Hill: Summit................. | 12 15 30 | 83 45 57 | | | | |
| | Bluefields: Schooner Pt............... | 11 59 00 | 83 41 57 | 1 40 | 7 52 | 2.0 | 1.1 |
| | Little Corn Island: Gun Pt........... | 12 17 30 | 82 58 35 | | | | |
| | Great Corn Island: Wells N. of Quin Bluff. | 12 09 17 | 83 03 35 | 1 35 | 7 47 | 2.0 | 1.1 |
| | Greytown: Light-house............... | 10 56 15 | 83 42 15 | 1 00 | 7 13 | 1.5 | 0.8 |
| C.R. | Mount Cartago: Peak, 11,100 feet........ | 10 01 30 | 83 47 27 | | | | |
| | Port Limon: Grape Cay light .......... | 10 00 05 | 83 02 00 | 1 00 | 7 13 | 1.6 | 0.9 |
| Colombia. | Carreta Point: Extreme.................. | 9 38 30 | 82 39 06 | | | | |
| | Tirby Point: Extreme ................ | 9 25 45 | 82 21 47 | | | | |
| | Columbus Island: Lime Pt............. | 9 24 47 | 82 20 31 | | | | |
| | Blanco Peak: Summit, 11,740 feet ...... | 9 16 30 | 83 03 27 | | | | |
| | Shepherd Island: Hut on summit ...... | 9 14 22 | 82 20 33 | | | | |
| | Cobbler Rock: Center ............... | 9 14 30 | 82 07 51 | | | | |
| | Valiente Peak: Summit, 722 feet........ | 9 10 30 | 81 55 02 | | | | |
| | Escudo de Veragua: W. pt. of island.... | 9 06 30 | 81 33 57 | | | | |

### WEST COAST OF NORTH AMERICA.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| Alaska. | Point Barrow: Highest lat. of U. S ..... | 71 23 30 | 156 27 00 | 11 41 | 5 33 | 0.6 | 0.2 |
| | Icy Cape: Extreme................... | 70 16 00 | 161 47 30 | | | | |
| | Cape Lisburne: 849 feet............... | 68 52 00 | 166 06 00 | | | | |
| | Cape Krusenstern: Extreme .......... | 67 09 00 | 163 34 00 | | | | |
| | Chamisso Island: Summit............. | 66 14 30 | 161 45 00 | 7 45 | 1 50 | 2.0 | 0.6 |
| | Cape Espenberg: Extreme ........... | 66 32 00 | 163 36 00 | | | | |
| | Diomede Island: Fairway Rock ....... | 65 35 30 | 168 40 00 | | | | |
| | Cape Prince of Wales: W. pt ......... | 65 33 30 | 168 00 00 | | | | |
| | Port Clarence: Point Spencer.......... | 65 16 40 | 166 46 30 | 6 10 | 1 10 | 1.1 | 0.9 |
| | King Island: N. pt ................. | 65 00 00 | 168 02 00 | | | | |
| | Cape Nome: Extreme ................ | 64 26 00 | 165 05 00 | [2 05] | [8 25] | [2.1] | |
| | St. Michael: Fort.................... | 63 26 00 | 162 02 30 | [8 05] | [1 20] | [4.5] | |
| | Stuart Island: W. pt................. | 63 34 30 | 162 42 30 | | | | |
| | Cape Romanzof: Extreme............. | 61 40 00 | 166 15 00 | | | | |
| | St. Lawrence Island: E. pt ........... | 63 16 00 | 168 41 00 | | | | |
| | NW. pt ............ | 63 50 00 | 171 31 00 | | | | |
| | St. Matthew Island: SE. pt........... | 60 18 00 | 172 02 00 | 4 40 | 11 0 | 3.1 | 1.6 |
| | Pinnacle Islet: Summit, 930 feet....... | 60 13 00 | 172 36 00 | | | | |
| | Nunivak Island: Cape Etolin.......... | 60 25 22 | 166 08 30 | | | | |
| | Hagenmeister Island.................. | 58 48 31 | 160 50 00 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

**WEST COAST OF NORTH AMERICA**—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Alaska.** | Cape Menchikof: Extreme ............... | 57 30 24 | 157 58 30 | ........ | ........ | ...... | ...... |
| | Port Moller ............................ | 55 54 59 | 160 34 54 | ........ | ........ | ...... | ...... |
| | St. George Island: S. side ............ | 56 34 23 | 169 39 50 | ........ | ........ | ...... | ...... |
| | | | Long. E. | | | | |
| | Attu Island: Chichagof Harbor......... | 52 56 01 | 173 12 24 | 3 35 | 9 48 | 5.7 | 2.9 |
| **Aleutian Islands.** | Kiska Island: Kiska Harbor, Ast. sta... | 51 59 04 | 177 30 00 | 3 30 | 9 43 | 5.2 | 2.7 |
| | Amchitka Island: Constantine Harbor.. | 51 23 39 | 179 12 06 | ........ | ........ | ...... | ...... |
| | | | Long. W. | | | | |
| | Adakh Island: Bay of Islands .......... | 51 49 18 | 176 52 00 | 3 25 | 9 38 | 5.0 | 2.6 |
| | Atka Island: Nazan Bay (church) ...... | 52 10 36 | 174 15 18 | ........ | ........ | ...... | ...... |
| | Pribilof Island: St. Paul I., village ...... | 57 07 19 | 170 17 52 | 4 17 | 10 29 | 2.7 | 1.4 |
| | Unalaska Island: C. S. station, Iliuliuk . | 53 52 54 | 166 31 44 | 3 50 | 9 58 | 2.9 | 1.5 |
| | Sannakh Reefs: S. edge ............... | 54 13 30 | 162 38 00 | 12 13 | 6 10 | 5.7 | 2.8 |
| | Sannakh Island: NE. end .............. | 54 26 12 | 162 18 00 | ........ | ........ | ...... | ...... |
| | Unga Island........................... | 55 20 45 | 160 38 39 | 2 40 | 8 55 | 8.2 | 4.1 |
| | Popof Island: Humboldt I ............. | 55 19 17 | 160 31 14 | ........ | ........ | ...... | ...... |
| | Nagai Island: Sanborn Harbor.......... | 55 07 36 | 159 56 06 | ........ | ........ | ...... | ...... |
| | Koniushi Island: NW. harbor.......... | 55 03 17 | 159 23 05 | ........ | ........ | ...... | ...... |
| | NE. harbor .......... | 54 58 25 | 159 22 18 | ........ | ........ | ...... | ...... |
| | Simeonof Island: Simeonof Harbor ..... | 54 55 30 | 159 15 03 | 2 20 | 8 33 | 7.5 | 3.8 |
| **Alaska.** | Cape Strogonof: Extreme ............. | 56 48 00 | 158 46 00 | ........ | ........ | ...... | ...... |
| | Chignik Bay: Anchorage. ............. | 56 19 20 | 158 24 24 | ........ | ........ | ...... | ...... |
| | Anowik Island: S. end................. | 56 05 13 | 156 39 19 | 1 45 | 7 58 | 8.1 | 4.0 |
| | Chiachi Islands....................... | 55 51 58 | 159 05 24 | ........ | ........ | ...... | ...... |
| | Light-House Rocks .................... | 55 45 24 | 157 27 04 | ........ | ........ | ...... | ...... |
| | Chirikof Island....................... | 55 48 22 | 155 42 51 | ........ | ........ | ...... | ...... |
| | Kodiak Island, St. Paul Harbor: Cove NW. of village.................... | 57 47 57 | 152 21 21 | 0 16 | 6 24 | 9.0 | 4.5 |
| | Port Etches .......................... | 60 20 43 | 146 37 38 | 0 50 | 7 05 | 10.1 | 5.1 |
| | Middleton Island ..................... | 59 27 22 | 146 18 45 | ........ | ........ | ...... | ...... |
| | Mount St. Elias: Summit.............. | 60 20 45 | 141 00 12 | ........ | ........ | ...... | ...... |
| | Yakutat Bay: Port Mulgrave ........... | 59 33 42 | 139 46 16 | 0 34 | 6 41 | 9.5 | 5.0 |
| | Lituya Bay ........................... | 58 36 57 | 137 40 06 | ........ | ........ | ...... | ...... |
| | Sitka: Middle of parade ground......... | 57 02 52 | 135 19 31 | 0 06 | 6 17 | 9.9 | 5.2 |
| | Juneau .............................. | 58 18 00 | 134 24 00 | 0 45 | 6 56 | 18.6 | 9.7 |
| | Wrangell: Ast. station ................ | 56 27 00 | 132 23 00 | 0 30 | 6 39 | 17.7 | 9.2 |
| **Queen Charlotte Is.** | North Island: N. pt................... | 54 15 00 | 132 56 20 | ........ | ........ | ...... | ...... |
| | Cape Knox: Extreme.................. | 54 10 30 | 132 57 50 | ........ | ........ | ...... | ...... |
| | Port Kuper: Sansum I ................. | 52 56 31 | 132 09 06 | 0 00 | 6 12 | 11.5 | 6.1 |
| | Forsyth Point: Extreme ............... | 52 09 07 | 131 03 20 | ........ | ........ | ...... | ...... |
| | St. James Cape: S. extreme ........... | 51 54 00 | 131 01 26 | ........ | ........ | ...... | ...... |
| | Cumshewa Harbor: N. side of entrance . | 53 02 00 | 131 31 00 | ........ | ........ | ...... | ...... |
| | Skidegate Bay: Rock on bar............ | 53 22 20 | 131 51 00 | 0 07 | 6 19 | 12.8 | 6.7 |
| | Rose Spit Point: Extreme ............. | 54 13 00 | 131 34 00 | ........ | ........ | ...... | ...... |
| | Massett Harbor: Uttewas village........ | 54 01 40 | 132 10 00 | ........ | ........ | ...... | ...... |
| | Cape Edenshaw: Extreme.............. | 54 04 30 | 132 20 56 | ........ | ........ | ...... | ...... |
| **Vancouver Island.** | Hecate Bay: Observatory Islet.......... | 49 15 22 | 125 55 43 | 12 15 | 6 08 | 10.0 | 5.8 |
| | Stamp Harbor: Observatory Islet........ | 49 13 46 | 124 50 07 | 0 45 | 7 20 | 12.4 | 7.1 |
| | Island Harbor: Observatory Islet........ | 48 54 41 | 125 16 54 | ........ | ........ | ...... | ...... |
| | Cape Beale: Light-house ............... | 48 47 23 | 125 13 14 | 12 20 | 6 15 | 9.9 | 5.7 |
| | Refuge Cove: Village on W. side ...... | 49 20 50 | 126 16 06 | ........ | ........ | ...... | ...... |
| | Hesquiat Harbor: Boat Cove ........... | 49 27 31 | 126 24 53 | 12 05 | 5 56 | 10.3 | 5.9 |
| | Estevan Point: S. extreme ............. | 49 22 07 | 126 31 58 | ........ | ........ | ...... | ...... |
| | Nootka Sound: Friendly Cove........... | 49 35 31 | 126 36 58 | 12 05 | 5 55 | 9.8 | 5.6 |
| | Port Langford: Colwood Islet ......... | 49 47 20 | 126 56 31 | ........ | ........ | ...... | ...... |
| | Esperanza Inlet: Observatory Rock..... | 49 52 45 | 126 59 21 | 11 55 | 5 45 | 9.7 | 5.5 |
| | Kyuquot Sound: Shingle Point......... | 49 59 55 | 127 08 56 | 11 50 | 5 38 | 9.3 | 5.3 |
| | Nasparti Inlet: Head Beach ........... | 50 11 21 | 127 37 24 | 11 47 | 5 34 | 9.3 | 5.3 |
| | Cook Cape: Solander I................. | 50 06 31 | 127 56 46 | ........ | ........ | ...... | ...... |
| | North Harbor: Observatory Rock........ | 50 29 25 | 128 03 05 | ........ | ........ | ...... | ...... |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### WEST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Vancouver I. | Koprino Harbor: Observatory Rock .... | 50 30 00 | 127 51 42 | ........ | ........ | ....... | ..... |
| | Hecate Cove: Kitten Islet............... | 50 32 26 | 127 35 44 | ........ | ........ | ....... | ..... |
| | Triangle Island: W. side ................ | 50 51 53 | 129 05 58 | ........ | ........ | ....... | ..... |
| | Cape Scott: Summit ................... | 50 46 41 | 128 26 11 | ........ | ........ | ....... | ..... |
| | Bull Harbor, Hope Island: N.pt. Indian I. | 50 54 47 | 127 55 29 | 0 10 | 6 22 | 10.7 | 5.6 |
| | Port Alexander: Islet in center.......... | 50 50 49 | 127 39 23 | 0 32 | 6 44 | 11.6 | 6.1 |
| | Beaver Harbor: Shell Islet.............. | 50 42 36 | 127 24 33 | 0 30 | 6 42 | 11.5 | 6.0 |
| | Cormorant I.: Yellow Bluff in Alert Bay. | 50 35 02 | 126 56 56 | 0 55 | 7 08 | 12.8 | 6.7 |
| | Baynes Sound: Beak Pt.................. | 49 36 29 | 124 50 44 | 4 45 | 11 00 | 10.6 | 6.6 |
| | Nanoose Harbor: Entrance Rock ....... | 49 15 43 | 124 07 32 | 4 52 | 11 18 | 10.2 | 6.4 |
| | Nanaimo: Light-house.................. | 49 12 50 | 123 48 11 | ........ | ........ | ....... | ..... |
| |     Benson's House ........... | 49 10 15 | 123 56 02 | 4 40 | 11 05 | 9.8 | 6.1 |
| | Victoria: Light-house................... | 48 25 26 | 123 23 28 | [2 17] | [8 31] | [5.7] | ..... |
| | Esquimalt: Fisgard I. light............. | 48 25 50 | 123 26 46 | [2 00] | [8 14] | [5.8] | ..... |
| | Race Island: Light-house ............... | 48 17 53 | 123 31 47 | ........ | ........ | ....... | ..... |
| | Sooke Inlet: Secretary I ............... | 48 19 35 | 123 42 40 | ........ | ........ | ....... | ..... |
| | Port San Juan: Pinnacle Rock.......... | 48 33 30 | 124 27 37 | ........ | ........ | ....... | ..... |
| British Columbia. | Port Harvey: Tide Pole Islet ............ | 50 33 58 | 126 16 06 | 1 55 | 8 10 | 14.1 | 7.4 |
| | Port Neville: Robber's Nob ............. | 50 31 09 | 126 03 47 | 2 30 | 8 47 | 16.0 | 8.3 |
| | Knox Bay, Thurlow Island: Stream at head of bay ......................... | 50 24 15 | 125 38 26 | 3 40 | 10 00 | 15.7 | 7.7 |
| | Valdes Island: S. pt.................... | 50 02 42 | 125 14 34 | 4 45 | 10 15 | 7.2 | 4.8 |
| | Howe Sound: Plumper Cove ............ | 49 24 39 | 123 28 46 | 5 38 | 11 58 | 9.0 | 5.6 |
| | Atkinson Point: Light-house ........... | 49 19 42 | 123 15 54 | 5 20 | 11 35 | 7.8 | 4.9 |
| | Vancouver, Burrard Inlet: Govt. Reserve, English Bay .................... | 49 16 18 | 123 11 26 | 5 28 | 12 01 | 8.2 | 5.0 |
| | Fraser River: Garry Pt ................. | 49 07 04 | 123 11 27 | 5 11 | 11 23 | 7.0 | 4.4 |
| | New Westminster: Military barracks.... | 49 13 01 | 123 53 52 | ........ | ........ | ....... | .... |
| | Point Roberts: Parallel station ......... | 49 00 00 | 123 04 52 | ........ | ........ | ....... | .... |
| | Semiamoo Bay: Parallel station......... | 49 00 00 | 122 44 56 | 4 59 | 11 10 | 7.1 | 4.6 |
| Washington. | Admiralty Head: Light-house ......... | 48 09 19 | 122 40 34 | ........ | ........ | ....... | .... |
| | Steilacoom: Methodist Church ......... | 47 10 20 | 122 35 51 | 4 46 | 11 04 | 11.0 | 7.2 |
| | Seattle: C. S. ast. station ............. | 47 35 54 | 122 19 59 | 4 22 | 10 33 | 9.2 | 6.0 |
| | Port Townsend: C. S. ast. station ....... | 48 06 56 | 122 44 58 | 3 47 | 9 32 | 6.2 | 4.0 |
| | Smith Island: Light-house ............. | 48 19 07 | 122 50 36 | 3 40 | 9 28 | 5.6 | 3.7 |
| | New Dungeness: Light-house .......... | 48 10 52 | 123 06 31 | 2 42 | 8 34 | 5.0 | 3.3 |
| | Port Angeles: Ediz Hook light-house ... | 48 08 24 | 123 24 07 | 2 10 | 8 23 | 5.3 | 3.4 |
| | Cape Flattery: Light-house ............ | 48 23 30 | 124 44 06 | 0 08 | 6 16 | 7.1 | 4.1 |
| | Cape Shoalwater: Light-house.......... | 46 43 00 | 124 04 25 | ........ | ........ | ....... | .... |
| | Cape Disappointment: Light-house ..... | 46 16 29 | 124 03 11 | 12 22 | 6 19 | 7.7 | 4.5 |
| | Kalama: Methodist Church ............ | 46 00 26 | 122 50 39 | 3 39 | 11 25 | 3.2 | 1.9 |
| | Bremerton: Navy-yard flagstaff......... | 47 33 24 | 122 37 33 | 4 27 | 10 35 | 9.4 | 6.1 |
| | Tacoma: St. Luke Church .............. | 47 15 32 | 122 26 26 | 4 32 | 10 45 | 9.8 | 6.4 |
| Oregon. | Astoria: Flagstaff ..................... | 46 11 19 | 123 49 42 | 0 15 | 6 42 | 7.8 | 4.7 |
| | Yaquina Head: Light-house............ | 44 40 35 | 124 04 40 | 11 50 | 5 37 | 7.3 | 4.3 |
| | Cape Arago, or Gregory: Light-house ... | 43 20 36 | 124 22 31 | 11 55 | 5 49 | 6.0 | 3.5 |
| | Cape Blanco: Light-house.............. | 42 50 22 | 124 33 30 | ........ | ........ | ....... | .... |
| California. | Crescent City: Light-house............. | 41 44 36 | 124 12 10 | 11 33 | 5 15 | 5.8 | 3.4 |
| | Trinidad Head: Light-house............ | 41 03 01 | 124 09 03 | 11 27 | 5 11 | 5.7 | 3.3 |
| | Eureka: Methodist Church ............. | 40 48 11 | 124 09 41 | 11 57 | 5 45 | 5.7 | 3.3 |
| | Humboldt: Light-house................ | 40 41 37 | 124 16 26 | 11 33 | 5 19 | 5.3 | 3.1 |
| | Cape Mendocino: Light-house.......... | 40 26 18 | 124 24 25 | 11 00 | 4 50 | 4.7 | 3.0 |
| | Point Arena: Light-house ............. | 38 57 12 | 123 44 27 | 10 36 | 4 21 | 4.1 | 2.6 |
| | Point Reyes: Light-house ............. | 37 59 39 | 123 01 24 | 11 23 | 5 08 | 5.1 | 3.2 |
| | San Francisco: Coast Survey ast. station. | 37 47 55 | 122 24 32 | 12 07 | 5 34 | 5.1 | 3.2 |
| |     Presidio station ......... | 37 47 30 | 122 27 49 | 11 43 | 5 07 | 4.6 | 2.9 |
| | Mare Island: Stone block, obs. station... | 38 05 53 | 122 16 24 | 1 05 | 7 15 | 5.6 | 3.7 |
| | Benicia: Church ...................... | 38 03 05 | 122 09 23 | 1 35 | 7 48 | 5.6 | 3.7 |
| | Farallon Islet: Light-house ............ | 37 41 51 | 123 00 07 | 10 40 | 4 25 | 4.5 | 2.9 |
| | Santa Clara: Catholic Church ......... | 37 20 49 | 121 56 26 | ........ | ........ | ....... | .... |
| | Mount Hamilton: Obs. peak............ | 37 21 03 | 121 36 40 | ........ | ........ | ....... | .... |
| | San José: Spire....................... | 37 19 58 | 121 53 39 | ........ | ........ | ....... | .... |
| | Pigeon Point: Light-house ............. | 37 10 49 | 122 23 39 | ........ | ........ | ....... | .... |

MARITIME POSITIONS AND TIDAL DATA.

**WEST COAST OF NORTH AMERICA—Continued.**

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| California. | Santa Cruz: Warehouse flagstaff........ | 36 57 31 | 122 01 29 | 10 54 | 4 27 | 5.2 | 3.3 |
| | Monterey: C. S. azimuth station........ | 36 35 21 | 121 52 59 | 10 43 | 4 24 | 4.8 | 3.1 |
| | Point Pinos: Light-house............ | 36 37 55 | 121 56 02 | ........ | ........ | ........ | .... |
| | Piedras Blancas: Light-house......... | 35 39 50 | 121 17 06 | ........ | ........ | ........ | .... |
| | Point Conception: Light-house ......... | 34 26 49 | 120 28 18 | ........ | ........ | ........ | .... |
| | Santa Barbara: N. tower, Mission Church | 34 26 10 | 119 42 42 | 9 37 | 3 15 | 4.8 | 2.2 |
| | San Buenaventura: C. S. ast. station .... | 34 15 46 | 119 15 56 | 9 53 | 3 21 | 4.9 | 2.2 |
| | Pt. Fermin, San Pedro Bay: Light-house. | 33 42 14 | 118 17 41 | 9 36 | 3 13 | 5.5 | 2.5 |
| | Los Angeles: Court-house ............... | 34 03 05 | 118 14 32 | ........ | ........ | ........ | .... |
| | Point Loma: Light-house .............. | 32 39 48 | 117 14 37 | 9 29 | 3 07 | 5.2 | 2.3 |
| | San Diego: C. S. ast. station............ | 32 43 06 | 117 09 41 | 9 32 | 3 20 | 5.1 | 2.3 |
| | Mexican Boundary: Obelisk .......... | 32 31 58 | 117 07 32 | ........ | ........ | ........ | .... |
| | San Miguel Island: Seal Pt............. | 34 04 19 | 120 21 55 | 9 23 | 3 02 | 4.9 | 2.2 |
| | Santa Rosa Island: E. pt.............. | 33 56 30 | 119 58 29 | ........ | ........ | ........ | .... |
| | Santa Cruz Island: NE. pt .......... | 34 03 12 | 119 33 51 | 9 29 | 3 06 | 4.9 | 2.2 |
| | Anacapa Island: E. pt .............. | 34 00 25 | 119 23 04 | ........ | ........ | ........ | .... |
| | Santa Barbara Island: Summit .......... | 33 28 16 | 119 02 29 | ........ | ........ | ........ | .... |
| | San Nicolas Island: Summit............. | 33 14 55 | 119 31 19 | 9 20 | 3 04 | 4.9 | 2.2 |
| | Santa Catalina Island: Catalina Peak ... | 33 23 09 | 118 24 05 | 9 28 | 3 08 | 5.1 | 2.3 |
| Lower California. | Ensenada Harbor: Head of bay, close to beach...................... | 31 51 10 | 116 38 05 | 9 28 | 3 06 | 5.0 | 2.2 |
| | San Tomas: NW. shore of cove ......... | 31 33 04 | 116 40 51 | ........ | ........ | ........ | .... |
| | Colnett Bay: Head of bay............... | 30 57 39 | 116 17 28 | 9 27 | 3 05 | 5.8 | 2.6 |
| | San Martin Island: Hassler Cove ....... | 30 28 58 | 116 06 46 | ........ | ........ | ........ | .... |
| | Port San Quentin: Sextant Pt .......... | 30 22 16 | 115 59 07 | 9 23 | 3 00 | 4.9 | 2.2 |
| | San Geronimo Island: Bight at E. end .. | 29 47 20 | 115 48 12 | ........ | ........ | ........ | .... |
| | Canoas Point: High bluff .............. | 29 25 29 | 115 12 14 | ........ | ........ | ........ | .... |
| | Guadeloupe: North pt ................ | 29 10 50 | 118 18 30 | ........ | ........ | ........ | .... |
| | La Playa Maria: Mound on W. side..... | 28 56 06 | 114 31 06 | 9 15 | 2 53 | 7.6 | 3.4 |
| | Santa Rosalia Bay: Obs. spot, Cairn .... | 28 40 16 | 114 14 15 | ........ | ........ | ........ | .... |
| | Lagoon Head: Highest pt. of crater..... | 28 14 26 | 114 06 21 | ........ | ........ | ........ | .... |
| | Cerros Island: SE. extremity........... | 28 03 52 | 115 11 32 | 9 05 | 2 42 | 7.8 | 3.5 |
| | San Benito Island: Summit of W. island. | 28 18 08 | 115 36 10 | ........ | ........ | ........ | .... |
| | San Bartolomé: N. side of entrance ..... | 27 39 35 | 114 54 27 | 9 00 | 2 37 | 8.2 | 2.8 |
| | Asuncion Island: Summit of island ..... | 27 06 10 | 114 .17 25 | ........ | ........ | ........ | .... |
| | San Ignacio Point: Extreme........... | 26 45 45 | 113 16 25 | ........ | ........ | ........ | .... |
| | Abreojos Point: Extreme of rocky ledge. | 26 42 49 | 113 35 04 | 9 00 | 2 48 | 6.7 | 2.3 |
| | San Domingo Point: Edge of cliff....... | 26 18 56 | 112 41 44 | ........ | ........ | ........ | .... |
| | San Juanico Point: Knoll ............. | 26 03 18 | 112 17 52 | 8 29 | 2 17 | 5.7 | 1.6 |
| | Alijos Rocks: South Rock............ | 24 58 00 | 115 51 54 | ........ | ........ | ........ | .... |
| | Cape San Lazaro: Extreme..........·... | 24 47 31 | 112 18 25 | ........ | ........ | ........ | .... |
| | Magdalena Bay: Obs. spot (post) N. of Port Magdalena ..................... | 24 38 23 | 112 08 54 | 8 25 | 2 12 | 5.5 | 1.5 |
| | Cape Tosco: Extreme ................. | 24 18 12 | 111 42 54 | ........ | ........ | ........ | .... |
| | El Conejo Point: Extreme ............ | 24 20 17 | 111 30 21 | ........ | ........ | ........ | .... |
| | Todos Santos: Foot of hill, Lobos Pt .... | 23 27 14 | 110 14 07 | ........ | ........ | ........ | .... |
| | San Lucas: Steep sand beach, NW. pt. of bay...................... | 22 53 07 | 109 54 50 | ........ | ........ | ........ | .... |
| | San José del Cabo: NE. side of entrance. | 23 03 35 | 109 40 43 | 8 36 | 2 20 | 4.5 | 1.2 |
| | Arena Point: Extreme................. | 23 32 48 | 109 28 57 | ........ | ........ | ........ | .... |
| | Arena de la Ventana: Extreme......... | 24 03 52 | 109 50 29 | ........ | ........ | ........ | .... |
| | Pichilinque Bay: SE. pt. of San Juan, Nepomezeino I..................... | 24 15 31 | 110 20 34 | ........ | ........ | ........ | .... |
| | La Paz: Obs. spot, El Mogote .......... | 24 10 10 | 110 20 41 | 9 40 | 3 34 | 5.4 | 1.3 |
| | Lupona Point: Extreme............... | 24 24 10 | 110 20 35 | ........ | ........ | ........ | .... |
| | San Evaristo: 3 m. S. of S. Evaristo Hd. | 24 52 03 | 110 41 47 | ........ | ........ | ........ | .... |
| | San Marcial Point: Extreme .......... | 25 29 23 | 111 01 43 | ........ | ........ | ........ | .... |
| | Salinas Bay: Beach, NE. pt. of bay ..... | 25 59 37 | 111 06 53 | ........ | ........ | ........ | .... |
| | Loreto: Cathedral ................... | 26 00 41 | 111 21 03 | ........ | ........ | ........ | .... |
| | Pulpito Point: Summit ................ | 26 30 44 | 111 27 14 | ........ | ........ | ........ | .... |
| | Muleje: Equipalito Pt................. | 26 53 37 | 111 58 04 | ........ | ........ | ........ | .... |
| | San Marcos Island: S. sand spit.......... | 27 10 21 | 112 05 39 | ........ | ........ | ........ | .... |
| | Santa Maria Cove: Beach on NW. shore. | 27 26 06 | 112 19 56 | ........ | ........ | ........ | .... |
| | San Carlos Point: Extreme............. | 28 00 07 | 112 47 36 | ........ | ........ | ........ | .... |
| | Santa Teresa Bay: Beach on N. side .... | 28 25 04 | 112 51 59 | 11 50 | 5 47 | 11.2 | 2.6 |

MARITIME POSITIONS AND TIDAL DATA.

## WEST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Lower California.** | Las Animas: Low pt.............. | 28 47 40 | 113 12 48 | | | | |
| | Raza Island: Landing place, S. side..... | 28 49 11 | 113 00 05 | | | | |
| | Angeles Bay: Bight on NW. shore...... | 28 56 39 | 113 34 35 | | | | |
| | Remedios Bay: Beach on W. shore..... | 29 13 52 | 113 40 00 | | | | |
| | Mejia Island: S. side............... | 29 33 08 | 113 35 19 | | | | |
| | San Luis Island: SE. side........ | 29 57 27 | 114 25 49 | | | | |
| | San Firmin: Beach, N. of bight........ | 30 25 16 | 114 39 47 | | | | |
| | San Felipe Point: Peak, 1,000 feet ...... | 31 02 57 | 114 52 10 | | | | |
| | Philips Point: Beacon ................. | 31 46 10 | 114 43 31 | | | | |
| | | | | | | | |
| | Georges Island: NE. shore ............. | 31 00 54 | 113 16 30 | | | | |
| | Cape Tepoca: Hill, 300 feet........ | 30 16 05 | 112 53 26 | | | | |
| | Libertad Anchorage: Beach ............ | 29 54 12 | 112 45 04 | | | | |
| | Patos Island: SE. end............... | 29 16 12 | 112 28 51 | | | | |
| | Tiburon Island: SE. end............. | 28 45 55 | 112 21 46 | | | | |
| | Kino Point: 0.2 mile N. 88° W. of mound. | 28 45 28 | 111 58 37 | | | | |
| **Mexico.** | San Pedro: N. side of bay.............. | 28 03 22 | 111 16 00 | | | | |
| | Guaymas: Light-house................. | 27 50 28 | 110 54 28 | 11 30 | 5 26 | 5.0 | 1.2 |
| | Ciaris Island: NW. part.............. | 26 58 59 | 109 57 17 | | | | |
| | Santa Barbara: NW. side of bay ........ | 26 41 09 | 109 40 48 | | | | |
| | Agiabampo: SE. side of entrance ....... | 26 16 35 | 109 17 30 | | | | |
| | Topolobampo: SE. end of Santa Maria I.. | 25 33 56 | 109 10 23 | | | | |
| | Navachista: W. side of creek........... | 25 23 06 | 108 49 00 | | | | |
| | Playa Colorado: N. side of entrance..... | 25 11 42 | 108 23 37 | | | | |
| | Altata: N. side of entrance ............. | 24 38 52 | 107 59 37 | 10 07 | 3 59 | 5.8 | 1.4 |
| | Mazatlan: Light-house ............... | 23 10 40 | 106 26 47 | 9 08 | 2 51 | 3.8 | 0.9 |
| | Palenita Village: Boca Tecapan......... | 22 30 26 | 105 44 25 | | | | |
| | San Blas: Custom-house ................. | 21 32 30 | 105 18 40 | 9 08 | 2 52 | 3.2 | 1.0 |
| | Maria Madre Island: SE. extreme ...... | 21 30 45 | 106 33 14 | | | | |
| | Mita Point: Extreme ................... | 20 45 50 | 105 33 37 | | | | |
| | Peñas Anchorage: Mouth of Rio Real... | 20 36 26 | 105 16 00 | | | | |
| | Cape Corrientes: Extreme.............. | 20 25 00 | 105 39 21 | | | | |
| | Perula Bay: Smooth Rock .............. | 19 34 48 | 105 08 54 | 9 07 | 2 53 | 2.5 | 1.1 |
| | San Benedicto Island: S. extreme....... | 19 17 15 | 110 49 22 | | | | |
| | Socorro Island: SE. part ................. | 18 42 57 | 110 56 53 | | | | |
| | Roca Partida: Summit ................. | 18 59 41 | 112 04 07 | | | | |
| | Clarion Island: S. end ................. | 18 20 55 | 114 44 17 | | | | |
| | Clipperton Island: Summit............. | 10 17 00 | 109 13 00 | | | | |
| | Navidad Bay: W. end of sandy beach... | 19 13 25 | 104 43 26 | | | | |
| | Manzanilla Bay: Flagstaff, U.S.consulate. | 19 03 15 | 104 19 50 | 9 07 | 2 54 | 1.9 | 1.3 |
| | Sacatula River: Beach, W. side of bay... | 17 58 21 | 102 07 06 | | | | |
| | Isla Grande: Tripod on NW. summit ... | 17 40 15 | 101 40 25 | | | | |
| | Sihuatanejo Point: Tree on beach........ | 17 37 50 | 101 33 23 | 8 50 | 2 38 | 2.0 | 0.9 |
| | Morro Petatlan: Junction of stony and sandy beaches...................... | 17 31 28 | 101 27 14 | | | | |
| | Tequepa Harbor: Limekiln ............. | 17 16 13 | 101 04 32 | | | | |
| | Acapulco: Light-house ................. | 16 49 10 | 99 55 50 | | | | |
| | Maldonado: El Recordo Pt.............. | 16 19 37 | 98 35 05 | | | | |
| | Port Angeles: Light-house ............. | 15 39 09 | 96 30 43 | | | | |
| | Sacrificios Point: Highest pt. of cape.... | 15 40 41 | 96 15 04 | | | | |
| | Port Guatulco: Cross ................. | 15 44 58 | 96 08 10 | | | | |
| | Morro Ayuca: Summit of N. edge of cape. | 15 52 17 | 95 46 43 | | | | |
| | Salina Cruz: Light-house................ | 16 09 49 | 95 12 31 | | | | |
| | | | | | | | |
| **Central America.** | Champerico: Inshore end of iron wharf.. | 14 17 44 | 91 55 36 | 2 50 | 9 02 | 8.5 | 4.6 |
| | San José de Guatemala: Light-house.... | 13 55 15 | 90 49 45 | 2 50 | 9 02 | 9.0 | 4.9 |
| | Acajutla: Light-house ................. | 13 34 20 | 89 50 26 | 2 55 | 9 08 | 9.5 | 5.1 |
| | Libertad: Light-house .................. | 13 28 49 | 89 19 25 | 3 05 | 9 18 | 10.0 | 5.4 |
| | La Union: Light-house ................. | 13 20 00 | 87 51 00 | 3 15 | 9 28 | 10.5 | 5.7 |
| | Chicarene Point: Extreme ............. | 13 17 09 | 87 47 06 | | | | |
| | Corinto: Light-house ................. | 12 27 54 | 87 12 31 | 2 55 | 9 08 | 10.5 | 5.7 |
| | San Juan del Sur: Signal station ........ | 11 14 45 | 85 52 59 | 3 00 | 9 12 | 10.0 | 5.4 |
| | Salinas Bay: Salinas Islet ............. | 11 03 10 | 85 43 38 | 2 50 | 9 02 | 9.5 | 5.1 |
| | Port Culebra: Extremity of Mala Pt .... | 10 36 46 | 85 42 46 | 2 45 | 8 58 | 9.0 | 4.9 |
| | Ballena Bay: N. Estero Toussa ......... | 9 43 45 | 85 00 46 | | | | |
| | Parida Anchorage: S. pt. of Deer Id..... | 8 10 13 | 82 14 32 | 3 15 | 9 28 | 10.5 | 5.7 |
| | Port Nuevo: Entrada Pt .............. | 8 04 30 | 81 43 30 | | | | |
| | Bahia Honda: W. end of Centinela I.... | 7 43 32 | 81 31 58 | 3 10 | 9 22 | 11.0 | 5.9 |
| | Coiba (Quibo) Island: Observation pt... | 7 24 20 | 81 41 51 | | | | |

## MARITIME POSITIONS AND TIDAL DATA.

### WEST COAST OF NORTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| C. America. | Cocos Island: Head of Chatham Bay.... | 5 32 57 | 86 59 17 | ........ | ........ | ..... | ..... |
| | Panama: NE. bastion, ast. station ...... | 8 57 12 | 79 32 05 | 3 00 | 9 14 | 16.0 | 8.7 |
| | Taboga Island: Church ................. | 8 47 45 | 79 33 16 | 3 00 | 9 13 | 15.4 | 8.3 |
| | Cape Mala: Extreme.................... | 7 27 40 | 79 59 25 | 3 10 | 9 22 | 13.0 | 7.0 |
| | Malpelo Island: Summit ............... | 4 03 00 | 81 36 00 | ........ | ........ | ..... | ..... |

### WEST INDIA ISLANDS.

| Coast. | Place. | Lat. N. | Long. W. | H. W. | L. W. | Spg. | Neap. |
|---|---|---|---|---|---|---|---|
| Bahama Islands. | Memory Rock: Center ................. | 26 56 53 | 79 06 54 | 7 40 | 1 28 | 3.2 | 1.7 |
| | Bahama Island: W. pt.................. | 26 41 18 | 79 00 38 | ........ | ........ | ..... | ..... |
| | Abaco Island: Light-house ............. | 25 51 30 | 77 10 45 | ........ | ........ | ..... | ..... |
| | Little Guana Cay: Light-house ......... | 26 31 10 | 76 57 36 | ........ | ........ | ..... | ..... |
| | Walker Cay: Highest part.............. | 27 15 42 | 78 23 48 | ........ | ........ | ..... | ..... |
| | Great Isaac Cay: Light-house ......... | 26 02 00 | 79 06 00 | ........ | ........ | ..... | ..... |
| | Gun Cay: Light-house ................. | 25 34 30 | 79 18 26 | 8 20 | 2 08 | 3.0 | 1.5 |
| | Ginger Cay: Center.................... | 22 45 10 | 78 06 02 | ........ | ........ | ..... | ..... |
| | Cay Lobos: Light-house................ | 22 22 30 | 77 34 26 | ........ | ........ | ..... | ..... |
| | St. Domingo Cay: Center ............. | 21 42 00 | 75 44 39 | ........ | ........ | ..... | ..... |
| | Cay Verde: Hill at S. end............. | 22 01 15 | 75 10 34 | ........ | ........ | ..... | ..... |
| | Ragged Island: Gun Pt .............. | 22 14 02 | 75 45 17 | ........ | ........ | ..... | ..... |
| | Nairn Cay: E. pt .................... | 22 20 44 | 75 28 20 | ........ | ........ | ..... | ..... |
| | Nurse Channel Cay: Beacon............ | 22 31 15 | 75 51 41 | ........ | ........ | ..... | ..... |
| | Long Island: S. pt................... | 22 51 00 | 74 51 54 | ........ | ........ | ..... | ..... |
| | Great Emma Island: Beacon .......... | 23 32 15 | 75 46 24 | ........ | ........ | ..... | ..... |
| | Clarence Harbor: Light-house.......... | 23 06 00 | 74 59 00 | 8 20 | 2 08 | 4.1 | 2.1 |
| | Eleuthera Island: Light-house ........ | 25 00 00 | 76 13 00 | 7 00 | 0 48 | 4.0 | 2.1 |
| | Royal Island: Eastern Pass............ | 25 31 20 | 76 51 48 | ........ | ........ | ..... | ..... |
| | Nassau: Light-house.................. | 25 05 37 | 77 21 58 | 7 20 | 1 08 | 4.0 | 2.1 |
| | Andros Island: Light-house ........... | 24 43 45 | 77 46 45 | 7 40 | 1 28 | 3.0 | 1.5 |
| | Great Stirrup Cay: Light-house ....... | 25 49 40 | 77 53 55 | ........ | ........ | ..... | ..... |
| | Little Stirrup Cay: W. end........... | 25 49 12 | 77 57 06 | ........ | ........ | ..... | ..... |
| | San Salvador (Cat I.): Light-house..... | 24 06 15 | 75 26 00 | 7 00 | 0 48 | 4.0 | 2.1 |
| | Concepcion Island: W. bay ........... | 23 50 50 | 75 07 27 | ........ | ........ | ..... | ..... |
| | Watlings Island: Hunchinbroke Rock .. | 23 56 40 | 74 28 20 | ........ | ........ | ..... | ..... |
| | Rum Cay: Harbor Pt................. | 23 37 45 | 74 50 08 | ........ | ........ | ..... | ..... |
| | Castle Island: Light-house ........... | 22 06 40 | 74 20 37 | ........ | ........ | ..... | ..... |
| | Fortune Island: S. end............... | 22 32 40 | 74 22 54 | ........ | ........ | ..... | ..... |
| | Crooked Island: Moss flagstaff......... | 22 47 30 | 74 20 21 | ........ | ........ | ..... | ..... |
| | Bird Island: Light-house.............. | 22 51 00 | 74 22 48 | ........ | ........ | ..... | ..... |
| | Samana Cay: W. pt.................. | 23 05 30 | 73 49 15 | ........ | ........ | ..... | ..... |
| | Plana Cay: NW. pt.................. | 22 34 38 | 73 38 03 | ........ | ........ | ..... | ..... |
| | Mariguana Island: SE. pt............. | 22 16 30 | 72 47 03 | 7 20 | 1 08 | 3.0 | 1.5 |
| | Hogsty Reef: NW. Cay .............. | 21 40 30 | 73 50 29 | ........ | ........ | ..... | ..... |
| | Inagua Island: Light-house ........... | 20 56 00 | 73 40 17 | 7 50 | 1 38 | 3.5 | 1.8 |
| | Little Inagua Island: NW. pt ......... | 21 30 40 | 73 42 33 | ........ | ........ | ..... | ..... |
| | W. Caicos Cay: Hill, SE. end ......... | 21 37 30 | 72 28 18 | ........ | ........ | ..... | ..... |
| | French Cay: W. pt .................. | 21 30 00 | 72 12 51 | ........ | ........ | ..... | ..... |
| | Fort George Cay: Old magazine ........ | 21 54 00 | 72 07 14 | ........ | ........ | ..... | ..... |
| | Caicos Island: Parsons Pt., S. islet...... | 21 29 33 | 71 31 12 | ........ | ........ | ..... | ..... |
| | Turk Island: Light-house ............. | 21 30 55 | 71 07 29 | 7 30 | 1 18 | 3.0 | 1.5 |
| | Square Handkerchief Bank: NE. breaker | 21 06 30 | 70 29 54 | ........ | ........ | ..... | ..... |
| | Silver Bank: E. extreme ............. | 20 35 00 | 69 21 24 | ........ | ........ | ..... | ..... |
| | Navidad Bank: Center of E. side ....... | 20 02 00 | 68 47 24 | ........ | ........ | ..... | ..... |
| Cuba. | Cape Maysi: Light-house ............. | 20 15 10 | 74 09 41 | 5 40 | 11 53 | 2.8 | 1.6 |
| | Port Baracoa: Light-house............. | 20 21 40 | 74 29 34 | ........ | ........ | ..... | ..... |
| | Port Cayo Moa: Carenero Pt ......... | 20 41 41 | 74 53 44 | ........ | ........ | ..... | ..... |
| | Port Nipe: Roma Pt ................. | 20 47 14 | 75 33 18 | ........ | ........ | ..... | ..... |
| | Lucrecia Point: Light-house........... | 21 04 24 | 75 36 59 | ........ | ........ | ..... | ..... |
| | Port Sama: E. side of entrance ........ | 21 09 00 | 75 47 18 | ........ | ........ | ..... | ..... |
| | Peak of Sama: Summit, 885 feet ....... | 21 07 00 | 75 47 40 | ........ | ........ | ..... | ..... |
| | Port Naranjo: E. side of entrance ...... | 21 07 30 | 75 52 18 | ........ | ........ | ..... | ..... |
| | Jibara: Fort San Fernando............ | 21 07 05 | 76 07 48 | 6 20 | 0 03 | 2.4 | 1.4 |
| | Port Padre: Guinchos Pt............. | 21 18 30 | 76 35 34 | ........ | ........ | ..... | ..... |
| | Port Nuevitas: Light-house ........... | 21 38 54 | 77 05 32 | 7 00 | 0 48 | 2.2 | 1.2 |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### WEST INDIA ISLANDS—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Cuba.** | Maternillos Point: Light-house.......... | 21 40 02 | 77 08 04 | ........ | ........ | ...... | ...... |
| | Cay Verde: NW. end.................... | 22 08 45 | 77 37 33 | ........ | ........ | ...... | ...... |
| | Cay Confites: S. pt.................... | 22 11 14 | 77 39 23 | ........ | ........ | ...... | ...... |
| | Paredon Grande Cay: Light-house....... | 22 29 10 | 78 09 11 | 7 20 | 1 08 | 2.8 | 1.6 |
| | Cay Sal: Light-house ................. | 23 56 30 | 80 27 51 | ........ | ........ | ...... | ...... |
| | Bahia de Cadiz Cay: Light-house....... | 23 12 34 | 80 29 26 | ........ | ........ | ...... | ...... |
| | Piedras Cay: Light-house ............. | 23 14 10 | 81 07 20 | ........ | ........ | ...... | ...... |
| | Matanzas: Summit of peak ............. | 23 01 54 | 81 43 18 | 8 30 | 2 18 | 2.2 | 1.2 |
| | Habana: Morro light-house ............ | 23 09 21 | 82 21 30 | 8 18 | 1 56 | 1.3 | 0.7 |
| | Transit pier, arsenal yard ..... | 23 08 03 | 82 21 17 | ........ | ........ | ...... | ...... |
| | Cape San Antonio: Light-house ........ | 21 51 44 | 84 57 28 | 8 30 | 2 18 | 1.5 | 0.9 |
| | San Felipe Cays: SW. pt............... | 21 55 00 | 83 31 18 | ........ | ........ | ...... | ...... |
| | Isle of Pines: Port Frances........... | 21 35 30 | 83 09 13 | ........ | ........ | ...... | ...... |
| | Piedras Cay: Light-house ............. | 21 57 45 | 81 07 18 | ........ | ........ | ...... | ...... |
| | Cienfuegos: Colorados Pt. light......... | 22 01 58 | 80 26 32 | 4 47 | 11 00 | 2.0 | 1.1 |
| | Cape Cruz: Light-house............... | 19 50 13 | 77 43 30 | ........ | ........ | ...... | ...... |
| | Santiago de Cuba: Light-house ........ | 19 57 31 | 75 52 12 | 8 20 | 2 30 | 2.2 | 1.1 |
| | Port Guantanamo: Fisherman Pt....... | 19 54 39 | 75 09 27 | 7 50 | 2 00 | 2.6 | 1.3 |
| | Cayman Brac: E. pt .................. | 19 45 15 | 79 46 07 | ........ | ........ | ...... | ...... |
| | Little Cayman: W. pt................. | 19 39 10 | 80 07 17 | ........ | ........ | ...... | ...... |
| | Grand Cayman: Fort George, W. end... | 19 17 45 | 81 23 17 | ........ | ........ | [1.3] | ...... |
| **Jamaica.** | Morant Point: Light-house............. | 17 55 05 | 76 11 08 | ........ | ........ | [1.1] | ...... |
| | Port Antonio: Folly Pt. Light.......... | 18 11 31 | 76 26 31 | ........ | ........ | ...... | ...... |
| | Port Maria: NW. wharf............... | 18 23 00 | 76 54 22 | ........ | ........ | ...... | ...... |
| | St. Ann Bay: Long wharf.............. | 18 26 24 | 77 12 52 | ........ | ........ | [1.2] | ...... |
| | Falmouth: Fort ...................... | 18 30 34 | 77 39 52 | ........ | ........ | ...... | ...... |
| | Montego Bay: Fort.................... | 18 29 25 | 77 56 16 | ........ | ........ | ...... | ...... |
| | St. Lucia: Fort...................... | 18 27 45 | 78 10 52 | ........ | ........ | ...... | ...... |
| | Savanna-la-Mar: Fort................. | 18 12 20 | 78 08 54 | ........ | ........ | ...... | ...... |
| | Kingston: Plum Pt. light.............. | 17 55 32 | 76 46 45 | ........ | ........ | ...... | ...... |
| | Port Royal: Fort Charles, flagstaff...... | 17 55 56 | 76 50 38 | ........ | ........ | [1.1] | ...... |
| | Morant Cays: NE. Cay .............. | 17 26 30 | 75 58 20 | ........ | ........ | ...... | ...... |
| | Pedro Bank: Portland Rock, E. end.... | 17 06 20 | 77 26 28 | ........ | ........ | ...... | ...... |
| | Baxo Nuevo: Sandy Cay............... | 15 53 00 | 78 39 04 | ........ | ........ | ...... | ...... |
| **Haiti.** | Samana Town: Fort .................. | 19 12 29 | 69 19 23 | 9 00 | 2 48 | 3.0 | 1.5 |
| | Cape Cabron: Extreme ............... | 19 21 17 | 69 16 00 | ........ | ........ | ...... | ...... |
| | Port Plata: Light-house............... | 19 48 51 | 70 41 27 | ........ | ........ | ...... | ...... |
| | Grange Point: W. end................ | 19 54 45 | 71 39 03 | ........ | ........ | ...... | ...... |
| | Manzanilla Point: Presidente Pt........ | 19 45 34 | 71 47 20 | 6 50 | 0 39 | 5.5 | 2.9 |
| | Cape Haitien: Town fountain........... | 19 46 20 | 72 11 42 | ........ | ........ | ...... | ...... |
| | Port Paix: Wharf.................... | 19 57 40 | 72 49 45 | ........ | ........ | ...... | ...... |
| | Nicolas Mole: Fort George, flagstaff..... | 19 49 15 | 73 23 07 | ........ | ........ | ...... | ...... |
| | Gonaïves: Verreur Pt.................. | 19 25 42 | 72 42 52 | ........ | ........ | ...... | ...... |
| | Gonave Island: W. pt................. | 18 55 26 | 73 18 34 | ........ | ........ | ...... | ...... |
| | Arcadius Islands: Light-house.......... | 18 48 13 | 72 39 05 | ........ | ........ | ...... | ...... |
| | Port au Prince: Fort Islet light ......... | 18 33 54 | 72 22 01 | ........ | ........ | [1.2] | ...... |
| | Petite Rivière Village: Sand beach in front of huts ...................... | 18 37 15 | 74 23 55 | ........ | ........ | ...... | ...... |
| | Jeremie: Fort....................... | 18 38 15 | 74 05 54 | ........ | ........ | ...... | ...... |
| | Navassa Island: N. extreme........... | 18 25 10 | 75 02 03 | ........ | ........ | . | ...... |
| | Formigas Bank: Shoal spot............ | 18 33 00 | 75 44 24 | ........ | ........ | ...... | ...... |
| | Vache Island: Sand beach, near NW. pt. | 18 06 00 | 73 43 40 | ........ | ........ | ...... | ...... |
| | Jacmel: Wharf...................... | 18 13 30 | 72 34 30 | ........ | ........ | [2.5] | ...... |
| | Beata Island: NW. pt................. | 17 36 45 | 71 33 44 | ........ | ........ | ...... | ...... |
| | Frayle Rock: Center.................. | 17 37 00 | 71 41 00 | ........ | ........ | ...... | ...... |
| | Alta Vela: Summit ................... | 17 28 50 | 71 39 11 | ........ | ........ | ...... | ...... |
| | Avarena Point: Extreme............... | 18 07 00 | 70 59 18 | ........ | ........ | ...... | ...... |
| | Salinas Point (Caldera): Extreme ...... | 18 12 00 | 70 35 18 | ........ | ........ | ...... | ...... |
| | St. Domingo City: Light-house ......... | 18 27 54 | 69 52 59 | ........ | ........ | [2.2] | ...... |
| | Point Espada: Extreme................ | 18 19 43 | 68 27 34 | ........ | ........ | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

**WEST INDIA ISLANDS—Continued.**

| Coast | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Porto Rico. | Mona Island: Light-house .............. | 18 02 43 | 67 50 30 | ........ | ........ | ........ | ........ |
| | Mayaguez: Mouth of Mayaguez R ....... | 18 11 56 | 67 09 04 | 7 04 | 2 00 | 2.0 | 1.0 |
| | Aguadilla Bay: Village ................... | 18 25 09 | 67 16 08 | | | | |
| | San Juan de Porto Rico: Morro light-house.................................... | 18 28 56 | 66 07 28 | 8 21 | 2 20 | 1.3 | 0.9 |
| | Cape San Juan: Light-house ............ | 18 23 05 | 65 36 31 | | | | |
| | Guanica: Meseta Pt...................... | 17 57 10 | 66 54 11 | ........ | ........ | [1.0] | ........ |
| | Culebrita Island: Light-house .......... | 18 18 44 | 65 13 34 | [7 31] | [1 30] | [1.0] | ........ |
| | Vieques (Crab) Island: Port Ferro light. | 18 05 20 | 65 25 26 | [7 35] | [1 40] | [1.1] | ........ |
| | St. Thomas: Fort Christian, SW. bastion. | 18 20 23 | 64 55 52 | [7 11] | [0 58] | [1.2] | ........ |
| | St. John Island: Ram Head............. | 18 18 08 | 64 42 03 | ........ | ........ | ........ | ........ |
| | Tortola: Fort Burt..................... | 18 25 04 | 64 36 47 | ........ | ........ | ........ | ........ |
| | Virgin Gorda: Vixen Pt ................ | 18 30 39 | 64 21 48 | ........ | ........ | ........ | ........ |
| | Anegada: W. pt........................ | 18 45 11 | 64 24 58 | ........ | ........ | ........ | ........ |
| | E. extreme of reefs............ | 18 36 30 | 64 10 45 | ........ | ........ | ........ | ........ |
| | Christiansted, Santa Cruz: SW. bastion of fort ............................. | 17 45 09 | 64 42 16 | ........ | ........ | ........ | ........ |
| | Sombrero: Light-house ................. | 18 35 37 | 63 28 13 | ........ | ........ | ........ | ........ |
| | Dog Island: Center .................... | 18 16 42 | 63 16 00 | ........ | ........ | ........ | ........ |
| | Anguilla: Custom-house ................ | 18 13 06 | 63 04 39 | ........ | ........ | ........ | ........ |
| | St. Martin: Fort Marigot light........ | 18 04 07 | 63 05 45 | ........ | ........ | ........ | ........ |
| | St. Bartholomew: Fort Oscar............ | 17 53 58 | 62 51 30 | ........ | ........ | [1.5] | ........ |
| | Saba: Diamond Rock ................... | 17 39 10 | 63 15 16 | ........ | ........ | ........ | ........ |
| | St. Eustatius: Fort flagstaff........... | 17 29 10 | 62 59 09 | ........ | ........ | ........ | ........ |
| | St. Christopher: Basseterre Church ..... | 17 18 12 | 62 43 14 | ........ | ........ | ........ | ........ |
| | Booby Island: Center.................. | 17 13 38 | 62 35 25 | ........ | ........ | ........ | ........ |
| | Nevis: Fort Charles.................... | 17 07 52 | 62 37 29 | ........ | ........ | ........ | ........ |
| | Barbuda: Flagstaff, Martello Tower..... | 17 35 50 | 61 49 54 | ........ | ........ | ........ | ........ |
| | Antigua, English Harbor: Flagstaff, dockyard .......................... | 17 00 00 | 61 46 07 | ........ | ........ | [2.0] | ........ |
| | Sandy Island: Light-house ... | 17 06 54 | 61 55 11 | ........ | ........ | ........ | ........ |
| | Redonda Islet: Center ................. | 16 55 18 | 62 19 10 | ........ | ........ | ........ | ........ |
| | Montserrat: Plymouth Wharf .......... | 16 42 12 | 62 13 24 | ........ | ........ | ........ | ........ |
| | Guadeloupe, Basseterre: Light on mast.. | 15 59 50 | 61 44 09 | ........ | ........ | ........ | ........ |
| | Port Louis: Light on mast . | 16 25 09 | 61 32 15 | ........ | ........ | ........ | ........ |
| | Gozier Islet: Light-house.. | 16 11 57 | 61 29 40 | ........ | ........ | [1.3] | ........ |
| | Manroux Id.: Light-house. | 16 13 14 | 61 32 05 | ........ | ........ | ........ | ........ |
| | Point à Pitre: Jarry Mill. | 16 13 56 | 61 33 15 | ........ | ........ | ........ | ........ |
| | Desirade: E. pt........................ | 16 19 56 | 61 00 44 | ........ | ........ | ........ | ........ |
| | Petite Terre: Light-house .............. | 16 10 17 | 61 06 45 | ........ | ........ | ........ | ........ |
| | Marie Galante: Light-house ............ | 15 52 59 | 61 19 15 | ........ | ........ | ........ | ........ |
| | Saintes Islands: Tower on Chameau hill. | 15 51 32 | 61 35 55 | ........ | ........ | ........ | ........ |
| | Dominica, Prince Ruperts Bay: Sand beach W. of church....... | 15 34 34 | 61 28 14 | 4 00 | 10 12 | 1.5 | 0.8 |
| | Roseau: Flagstaff, Fort Young. | 15 17 27 | 61 23 52 | ........ | ........ | ........ | ........ |
| | Aves Island: Center ................... | 15 42 00 | 63 37 46 | ........ | ........ | ........ | ........ |
| | Martinique, Fort de France: Fort St. Louis light ............... | 14 35 44 | 61 04 30 | ........ | ........ | ........ | ........ |
| | St. Pierre: Ste. Marthe Battery ...................... | 14 43 54 | 61 11 12 | ........ | ........ | ........ | ........ |
| | Caravelle Pen.: Light-house. | 14 46 13 | 60 53 20 | 3 50 | 10 02 | 1.1 | 0.6 |
| | Cabrit Islet: Summit........ | 14 23 23 | 60 52 33 | ........ | ........ | ........ | ........ |
| | St. Lucia, Port Castries: Light-house.... | 14 01 54 | 61 00 48 | ........ | ........ | ........ | ........ |
| | Barbadoes, Bridgetown: Flagstaff, Rickett's Battery ............... | 13 05 42 | 59 37 19 | 2 50 | 9 02 | 3.0 | 1.5 |
| | S. Point: Light-house........ | 13 02 45 | 59 31 50 | ........ | ........ | ........ | ........ |
| | Ragged Point: Light-house .. | 13 09 40 | 59 26 04 | ........ | ........ | ........ | ........ |
| | St. Vincent, Kingstown: Light-house ... | 13 09 19 | 61 14 34 | 2 50 | 9 05 | 1.6 | 0.8 |
| | Bequia Island, Admiralty Bay: Church . | 13 00 25 | 61 14 09 | ........ | ........ | ........ | ........ |
| | Grenada: St. George light-house........ | 12 03 02 | 61 45 06 | 2 30 | 8 42 | 1.5 | 0.8 |
| | Tobago, Rocky Bay: Light-house........ | 11 10 08 | 60 42 38 | 3 50 | 10 02 | 2.1 | 1.1 |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### WEST INDIA ISLANDS—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Testigos Islets: Center of Testigo Grande. | 11 25 02 | 63 05 48 | ........ | ........ | ...... | ...... |
| | Sola Island: Center...................... | 11 19 00 | 63 36 00 | ........ | ........ | ...... | ...... |
| | Pampatar, Margarita I.: San Carlos Castle. | 10 59 43 | 63 48 00 | ........ | ........ | ...... | ...... |
| | Tortugas Island: S. end of W. Tortugillo Islet.................................. | 10 57 45 | 65 26 38 | ........ | ........ | ...... | ...... |
| | Orchila Island: S. side.................. | 11 47 57 | 66 12 31 | ........ | ........ | ...... | ...... |
| | Roques Islands: Pirate Cay ............. | 11 56 16 | 66 39 10 | ........ | ........ | ...... | ...... |
| | Bonaive Island: Light-house............ | 12 02 06 | 68 14 10 | ........ | ........ | ...... | ...... |
| | Little Curaçao Island: Light-house ..... | 11 59 30 | 68 39 19 | ........ | ........ | ...... | ...... |
| | Curaçao Island: Fort Nassau............ | 12 06 59 | 68 55 50 | ........ | ........ | ...... | ...... |
| | Light-house ........... | 12 06 17 | 68 56 16 | ........ | ........ | ...... | ...... |
| | Oruba Island: Light-house.............. | 12 31 05 | 70 02 34 | ........ | ........ | ...... | ...... |

### NORTH AND EAST COASTS OF SOUTH AMERICA.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | H. W. | L. W. | Spg. | Neap. |
| Colombia. | Chagres: San Lorenzo Castle ............. | 9 19 27 | 80 00 22 | ........ | ........ | ...... |
| | Toro Point: Light-house ................ | 9 22 39 | 79 57 16 | ........ | ........ | ...... |
| | Colon: Light-house..................... | 9 22 09 | 79 54 45 | 0 06 | 6 18 | 1.1 | 0.6 |
| | Porto Bello: Ft. St. Geronimo........... | 9 32 30 | 79 39 40 | ........ | ........ | ...... |
| | Caledonia Harbor: Scorpion Cay ....... | 8 54 52 | 77 42 25 | 11 30 | 5 17 | 1.5 | 0.8 |
| | Carreto Port: Peak ..................... | 8 47 00 | 77 38 00 | ........ | ........ | ...... |
| | Caribana Point: Extreme ............... | 8 37 30 | 76 52 55 | ........ | ........ | ...... |
| | Fuerte Island: N. extreme .............. | 9 24 00 | 76 10 45 | ........ | ........ | ...... |
| | Cispata Port: Zapote Pt................. | 9 24 00 | 75 48 00 | ........ | ........ | ...... |
| | Cartagena: Light-house................. | 10 25 50 | 75 32 50 | ........ | ........ | ...... |
| | Savanilla: Light-house.................. | 11 00 15 | 74 57 55 | ........ | ........ | ...... |
| | Magdalena River: NW. pt. of Gomez I.. | 10 07 00 | 74 49 51 | ........ | ........ | ...... |
| | Santa Marta: Light-house............... | 11 15 28 | 74 14 33 | ........ | ........ | ...... |
| | Rio de la Hacha: Light on church ...... | 11 33 30 | 72 54 50 | ........ | ........ | ...... |
| | Cape La Vela: Sand beach inside cape .. | 12 12 34 | 72 09 42 | ........ | ........ | ...... |
| | Bahia Honda: E. pt., S. side ........... | 12 23 09 | 71 45 42 | ........ | ........ | ...... |
| Venezuela. | Espada Point: Extreme.................. | 12 04 00 | 71 07 55 | ........ | ........ | ...... |
| | Maracaibo: Zapara I. light ............. | 10 57 30 | 71 37 00 | 5 05 | 11 17 | 2.5 | 1.5 |
| | Estangues Point: 500 ft. from extreme .. | 11 48 56 | 70 17 21 | ........ | ........ | ...... |
| | Cape San Roman: Extreme ............. | 12 11 00 | 70 04 55 | ........ | ........ | ...... |
| | Marjes Islets: N. islet................. | 12 29 15 | 70 57 00 | ........ | ........ | ...... |
| | Vela de Coro: Light-house.............. | 11 27 56 | 69 34 20 | ........ | ........ | ...... |
| | Tucacas Island: Ore house ............. | 10 47 00 | 68 19 55 | ........ | ........ | ...... |
| | St. Juan Bay: Cay...................... | 11 10 00 | 68 22 54 | ........ | ........ | ...... |
| | Puerto Cabello: Light-house ........... | 10 29 53 | 68 00 55 | ........ | ........ | ...... |
| | La Guaira: Light-house................. | 10 36 57 | 66 56 06 | 6 00 | 12 12 | 2.8 | 1.7 |
| | Cape Codera: Morro.................... | 10 35 00 | 66 06 15 | ........ | ........ | ...... |
| | Corsarios Bay: W. pt .................. | 10 34 06 | 66 04 13 | ........ | ........ | ...... |
| | Centinela Islet: Center................. | 10 49 30 | 66 09 25 | ........ | ........ | ...... |
| | Barcelona: Morro...................... | 10 13 30 | 64 44 00 | ........ | ........ | ...... |
| | Cumana: Light-house................... | 10 27 20 | 64 11 33 | ........ | ........ | ...... |
| | Escarseo Point: Extreme ............... | 10 40 00 | 64 17 55 | ........ | ........ | ...... |
| | Chacopata: Morro...................... | 10 42 00 | 63 50 25 | ........ | ........ | ...... |
| | Esmeralda Islet: Center ............... | 10 40 00 | 63 31 55 | ........ | ........ | ...... |
| | Carupano: Light-house ................ | 10 40 15 | 63 18 00 | ........ | ........ | ...... |
| | Pt. Herman Vasquez........ | 10 42 00 | 63 14 00 | ........ | ........ | ...... |
| | Puerto Santo Bay: Sand spit S. of Morro. | 10 43 07 | 63 09 43 | ........ | ........ | ...... |
| | Tres Puntas Cape: Extreme ............ | 10 45 00 | 62 41 55 | ........ | ........ | ...... |
| | Unare Bay: Obs. spot, 200 yds. S. of Morro | 10 44 19 | 62 44 29 | ........ | ........ | ...... |
| | Pena Point: Extreme................... | 10 43 48 | 61 50 50 | ........ | ........ | ...... |
| | Pato Island: E. pt ..................... | 10 38 15 | 61 51 18 | ........ | ........ | ...... |
| | Mocomoco Pt.: Extreme................ | 8 39 25 | 60 10 15 | ........ | ........ | ...... |
| Trinidad. | Port of Spain: King's Wharf light ...... | 10 38 37 | 61 30 38 | 4 20 | 10 30 | 3.2 | 1.9 |
| | Chacachacare Island: Rocks off SW. pt.. | 10 40 03 | 61 45 54 | ........ | ........ | ...... |
| | Galera Point: NE. extreme, light-house. | 10 50 02 | 60 54 10 | ........ | ........ | ...... |
| | Icacos Point: Light-house.............. | 10 03 29 | 61 55 41 | ........ | ........ | ...... |
| | San Fernando: Pierhead ............... | 10 16 59 | 61 28 12 | ........ | ........ | ...... |

## MARITIME POSITIONS AND TIDAL DATA.

### NORTH AND EAST COASTS OF SOUTH AMERICA—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Guiana. | Demerara: Georgetown light-house ..... | 6 49 20 | 58 11 30 | 4 18 | 9 50 | 8.6 | 3.9 |
| | Nickerie River: Light-house............. | 5 58 30 | 57 00 30 | ........ | ........ | ...... | ...... |
| | Paramaribo: Stone steps ............... | 5 49 30 | 55 08 48 | 5 50 | 12 00 | 9.5 | 4.3 |
| | Maroni River: W. light-house........... | 5 44 50 | 54 00 30 | ........ | ........ | ...... | ...... |
| | Salut Islands: Light-house ............. | 5 16 50 | 52 34 53 | ........ | ........ | ...... | ...... |
| | Enfant Perdu Islet: Light-house........ | 5 02 40 | 52 21 11 | ........ | ........ | ...... | ...... |
| | Cayenne: Light-house .................. | 4 56 20 | 52 20 26 | 4 27 | 10 30 | 6.0 | 2.7 |
| | Connétable Islet: Center ...........~... | 4 49 30 | 51 55 36 | ........ | ........ | ...... | ...... |
| | Carimare Mount: Summit.............. | 4 23 20 | 51 50 36 | ........ | ........ | ...... | ...... |
| | Orange Cape: Extreme ................ | 4 20 45 | 51 27 46 | ........ | ........ | ...... | ...... |
| | Mayé Mountain: Summit .............. | 2 46 30 | 50 54 46 | ........ | ........ | ...... | ...... |
| | North Cape: Extreme ................. | 1 40·17 | 49 56 46 | ........ | ........ | ...... | ...... |
| | | Lat. S. | | | | | |
| | Cape Magoari: Extreme .............. | 0 17 00 | 48 23 30 | ........ | ........ | ...... | ...... |
| | Para: Custom-house .................. | 1 26 59 | 48 30 01 | 11 50 | 5 37 | 11.0 | 5.2 |
| | Atalaia Point: Light-house............ | 0 35 03 | 47 20 54 | ........ | ........ | ...... | ...... |
| | Itacolomi Point: Light-house........... | 2 10 11 | 44 25 56 | ........ | ........ | ...... | ...... |
| | Maranhão Island: Landing place ....... | 2 31 48 | 44 18 45 | 6 50 | 0 38 | 16.5 | 7.9 |
| | Santa Anna Island: Light-house........ | 2 16 22 | 43 37 30 | 5 35 | 11 47 | 13.1 | 6.2 |
| | Tutoya: Entrance ..................... | 2 41 55 | 42 18 02 | 5 05 | 11 17 | 11.7 | 5.6 |
| | Paranahiba River: Amarção Village .... | 2 53 20 | 41 40 35 | ........ | ........ | ...... | ...... |
| | Ceará: Light-house ................... | 3 42 05 | 38 28 25 | 5 25 | 11 37 | 8.2 | 3.9 |
| | Jaguaribe River: Pilot station ......... | 4 25 35 | 37 44 55 | 5 50 | 12 00 | 8.0 | 3.8 |
| | Caiçara: Village ..................... | 5 03 15 | 36 02 52 | ........ | ........ | ...... | ...... |
| | Cape St. Roque: Extreme........ .... | 5 29 15 | 35 15 52 | 4 05 | 10 17 | 8.8 | 4.2 |
| Brazil. | Rio Grande do Norte: Light-house...... | 5 45 05 | 35 11 55 | ........ | ........ | ...... | ...... |
| | Natal: Cathedral .................... | 5 46 41 | 35 12 43 | ........ | ........ | ...... | ...... |
| | Parahiba River: Light-house at entrance. | 6 56 30 | 34 49 30 | ........ | ........ | ...... | ...... |
| | Parahiba: Cathedral .................. | 7 06 35 | 34 53 04 | ........ | ........ | ...... | ...... |
| | Olinda: Light-house .................. | 8 00 50 | 34 50 36 | ........ | ........ | ...... | ...... |
| | Pernambuco: Picao light-house......... | 8 03 22 | 34 51 57 | 4 33 | 10 50 | 7.0 | 3.3 |
| | Cape St. Augustine: Light-house........ | 8 20 45 | 34 56 05 | ........ | ........ | ...... | ...... |
| | Tamandaré: Village .................. | 8 43 40 | 35 05 06 | ........ | ........ | ...... | ...... |
| | Maceio: Light-house.................. | 9 39 35 | 35 44 54 | 4 20 | 10 32 | 8.5 | 4.1 |
| | San Francisco River: Light-house at en-trance ..................... | 10 30 30 | 36 21 51 | 4 17 | 10 29 | 7.8 | 3.7 |
| | Cotinguiba River: Light-house at en-trance ...................... | 10 58 20 | 37 04 00 | ........ | ........ | ...... | ...... |
| | Vaza Barris River: Semaphore at en-trance ...................... | 11 09 45 | 37 12 36 | ........ | ........ | ...... | ...... |
| | Real River: Light-house ............. | 11 27 40 | 37 24 00 | ........ | ........ | ...... | ...... |
| | Conde: Village...................... | 12 12 05 | 37 45 46 | ........ | ........ | ...... | ...... |
| | Garcia d'Avila: Tower ............... | 12 33 40 | 38 02 16 | ........ | ........ | ...... | ...... |
| | Bahia: Santo Antonio light-house....... | 13 00 37 | 38 32 06 | 4 10 | 10 22 | 7.6 | 3.6 |
| | Itaparica: Fort on N. pt.............. | 12 52 48 | 38 41 28 | ........ | ........ | ...... | ...... |
| | Morro de São Paulo: Light-house....... | 13 22 37 | 38 54 38 | 3 50 | 10 00 | 6.0 | 2.9 |
| | Camamu: Village.................... | 13 56 42 | 39 07 05 | 3 50 | 10 00 | 6.3 | 3.0 |
| | Contas: Church ..................... | 14 17 40 | 39 00 45 | ........ | ........ | ...... | ...... |
| | Ilheos: Church...................... | 14 47 40 | 39 03 25 | 3 35 | 9 47 | 6.4 | 3.1 |
| | Olivença: Center of village ........... | 14 56 40 | 39 01 45 | ........ | ........ | ...... | ...... |
| | Una: Center of village .............. | 15 13 27 | 39 01 15 | ........ | ........ | ...... | ...... |
| | Comandatuba: Center of village ........ | 15 21 00 | 39 16 45 | ........ | ........ | ...... | ...... |
| | Santa Cruz: Church ................. | 16 17 20 | 39 02 05 | 3 25 | 9 37 | 6.0 | 2.9 |
| | Porto Seguro: Matriz Church.......... | 16 25 38 | 39 04 15 | ........ | ........ | ...... | ...... |
| | Prado: River entrance ............... | 17 21 40 | 39 13 15 | ........ | ........ | ...... | ...... |
| | Alcobaça: Center of village........... | 17 31 45 | 39 12 00 | ........ | ........ | ...... | ...... |
| | Caravellas: Center of village.......... | 17 43 30 | 39 14 36 | 3 10 | 9 23 | 6.4 | 3.1 |
| | Abrolhos Island: Light-house......... | 17 57 31 | 38 41 46 | 3 15 | 9 27 | 7.5 | 3.6 |
| | Porto Alegre: Center of village ....... | 18 06 15 | 39 31 16 | ........ | ........ | ...... | ...... |
| | Espiritu Santo Bay: Light-house........ | 20 19 23 | 40 16 36 | 2 50 | 9 00 | 4.0 | 1.9 |
| | Guarapiri Islets: E. islet ............ | 20 38 25 | 40 23 46 | ........ | ........ | ...... | ...... |
| | Benevente: Village .................. | 20 49 00 | 40 40 45 | 2 40 | 8 52 | 5.0 | 2.4 |
| | Itapemirim: Moscas Islet............. | 20 57 35 | 40 46 35 | ........ | ........ | ...... | ...... |
| | São João da Barra: Light-house ....... | 21 38 40 | 41 02 21 | ........ | ........ | ...... | ...... |
| | Cape St. Thomé: Extreme ............ | 22 02 00 | 40 59 00 | ........ | ........ | ...... | ...... |
| | Macahé: Fort at entrance ............ | 22 23 45 | 41 47 35 | 2 20 | 8 30 | 9.2 | 4.4 |

MARITIME POSITIONS AND TIDAL DATA.

### NORTH AND EAST COASTS OF SOUTH AMERICA—Continued.

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Brazil. | Santa Anna Island: Summit............. | 22 26 00 | 41 43 15 | ........ | ........ | ....... | ....... |
| | Barra São João: Village .....·......... | 22 37 00 | 41 59 45 | ........ | ........ | ....... | ....... |
| | Busios: Church....................... | 22 46 00 | 41 54 05 | ........ | ........ | ....... | ....... |
| | Cape Frio: Light-house .................. | 23 00 42 | 42 00 00 | ........ | ........ | ....... | ....... |
| | Port Frio: Village ..................... | 22 53 15 | 42 01 15 | 2 30 | 8 42 | 4. 9 | 2. 3 |
| | Maricas Islands: S. islet.............. | 23 01 43 | 42 54 05 | ........ | ........ | ....... | ....... |
| | Rio de Janeiro: Fort Villegagnon Light. | 22 54 46 | 43 09 24 | 2 50 | 9 00 | 4. 2 | 2. 0 |
| | Imperial Observatory.... | 22 54 15 | 43 10 16 | ........ | ........ | ....... | ....... |
| | Raza Island: Light-house .............., | 23 03 40 | 43 08 45 | ........ | ........ | ....... | ....... |
| | Petropolis: Center of town ............. | 22 32 00 | 43 11 01 | ........ | ........ | ....... | ....... |
| | Cape Guaratiba: Summit................ | 23 03 40 | 43 33 24 | ........ | ........ | ....... | ....... |
| | Marambaya Island: Summit of SW. end. | 23 04 20 | 43 59 26 | ........ | ........ | ....... | ....... |
| | Mangaratiba: Village .................. | 22 57 20 | 44 02 29 | ........ | ........ | ....... | ....... |
| | Palmas Bay: Beach at head of bay...... | 23 09 20 | 44 08 24 | ........ | ........ | ....... | ....... |
| | Angra dos Reis: Landing-place ......... | 23 00 30 | 44 19 04 | ........ | ........ | ....... | ....... |
| | Ilha Grande: Light-house............... | 23 09 50 | 44 05 45 | ........ | ........ | ....... | ....... |
| | Parati: Fort.......................... | 23 12·20 | 44 42 04 | 1 35 | 7 47 | 5. 3 | 2. 5 |
| | Ubatuba: Cathedral ................... | 23 25 55 | 45 04 04 | ........ | ........ | ....... | ....... |
| | Porcos Grande Islet: Summit........... | 23 32 57 | 45 03 50 | ........ | ........ | ....... | ....... |
| | Busios Islets: Summit................. | 23 45 15 | 45 00 39 | ........ | ........ | ....... | ....... |
| | St. Sebastian Island: Boi Pt. light.... | 23 58 30 | 45 15 20 | ........ | ........ | ....... | ....... |
| | Villa Nova da Princessa: Center....... | 23 47 20 | 45 21 04 | ........ | ........ | ....... | ....... |
| | Santos: Moela I. light-house............ | 24 03 06 | 46 15 57 | ........ | ........ | ....... | ....... |
| | Quay....................... | 23 56 00 | 46 19 09 | 2 50 | 9 00 | 5. 0 | 2. 8 |
| | Alcatrasses Island: Summit, 880 ft ...... | 24 06 30 | 45 40 49 | ........ | ........ | ....... | ....... |
| | Conceição: Church .................... | 24 10 32 | 46 47 44 | ........ | ........ | ....... | ....... |
| | Quemada Grande Island: Summit,623ft.. | 24 28 45 | 46 41 04 | ........ | ........ | ....... | ....... |
| | Iguape: Quay ......................... | 24 42 35 | 47 32 54 | ........ | ........ | ....... | ....... |
| | Bom Abrigo Islet: Light-house ......... | 25 06 40 | 47 51 50 | ........ | ........ | ....... | ....... |
| | Ilha do Mel: Light-house .............. | 25 30 55 | 48 19 53 | ........ | ........ | ....... | ....... |
| | Paranagua: Quay ..................... | 25 31 20 | 48 31 03 | 2 55 | 9 05 | 6. 4 | 3. 1 |
| | Antonina: Quay ...................... | 25 26 30 | 48 43 14 | ........ | ........ | ....... | ....... |
| | Coral Islet: Center................... | 25 44 10 | 48 23 14 | ........ | ........ | ....... | ....... |
| | Itacolomi Islet: Center................ | 25 50 15 | 48 25 51 | ........ | ........ | ....... | ....... |
| | São Francisco: Center of town.......... | 26 14 17 | 48 39 29 | ........ | ........ | ....... | ....... |
| | Itapacaroya: Church................... | 26 46 45 | 48 36 59 | ........ | ........ | ....... | ....... |
| | Cambria: Church...................... | 27 01 35 | 48 36 44 | ........ | ........ | ....... | ....... |
| | Arvoredo Island: Light-house ......... | 27 18 00 | 48 22 20 | ........ | ........ | ....... | ....... |
| | Anhatomirim: Light-house............. | 27 25 30 | 48 34 25 | ........ | ........ | ....... | ....... |
| | St. Catharine Island: Rapa Pt.......... | 27 22 55 | 48 26 09 | 2 35 | 8 47 | 5. 9 | 2. 8 |
| | Naufragados light. | 27 50 27 | 48 35 16 | ........ | ........ | ....... | ....... |
| | Nostra Senhora do Deserto: Quay........ | 27 36 00 | 48 34 14 | ........ | ........ | ....... | ....... |
| | Coral Island: Summit, 230 feet ......... | 27 56 40 | 48 33 44 | ........ | ........ | ....... | ....... |
| | Cape St. Martha: Light-house .......... | 28 38 00 | 48 49 45 | ........ | ........ | ....... | ....... |
| | Torres Point: Extreme................. | 29 20 20 | 49 43 39 | ........ | ........ | ....... | ....... |
| | Rio Grande do Sul: Light-house........ | 32 06 40 | 52 07 44 | 4 00 | 10 12 | 1. 8 | 0. 9 |
| Uruguay. | Castillos: Beuna Vista Hill, 184 feet..... | 34 21 19 | 53 47 16 | 8 20 | 2 08 | 2. 0 | 0. 9 |
| | Cape Santa Maria: Light-house........ | 34 40 01 | 54 09 14 | ........ | ........ | ....... | ....... |
| | Lobos Island: Center................. | 35 01 39 | 54 53 16 | ........ | ........ | ....... | ....... |
| | Maldonado: Light-house............... | 34 58 15 | 54 57 10 | ........ | ........ | ....... | ....... |
| | Flores Island: Light-house ............ | 34 56 55 | 55 55 04 | ........ | ........ | ....... | ....... |
| | Montevideo: Cathedral, SE. tower...... | 34 54 33 | 56 12 15 | 2 00 | 8 12 | 3. 5 | 2. 3 |
| | Colonia: Light-house .................. | 34 28 20 | 57 52 27 | 6 30 | 0 00 | 4. 0 | 2. 7 |
| Argentina. | Martin Garcia Island: Light-house...... | 34 10 50 | 58 15 40 | ........ | ........ | ....... | ....... |
| | Buenos Ayres: Cupola of custom-house.. | 34 36 30 | 58 22 14 | 6 43 | 12 15 | 2. 1 | 1. 4 |
| | La Plata .............................. | 34 54 30 | 57 54 15 | ........ | ........ | ....... | ....... |
| | Indio Point: Light-house............... | 35 15 45 | 57 10 45 | ........ | ........ | ....... | ....... |
| | Piedras Point: Extreme................ | 35 26 50 | 57 05 28 | ........ | ........ | ....... | ....... |
| | Cape San Antonio: Light-house......... | 36 18 24 | 56 44 15 | 9 50 | 3 35 | 5. 3 | 3. 5 |
| | Madanas Point: Light-house........... | 36 53 00 | 56 38 54 | ........ | ........ | ....... | ....... |
| | Cape Corrientes: E. summit............ | 38 05 30 | 57 30 01 | ........ | ........ | ....... | ....... |
| | Port Belgrano: Anchor-Stock Hill ...... | 38 57 00 | 61 59 15 | 6 00 | 0 00 | 15. 8 | 8. 2 |
| | Argentina: Fort ...................... | 38 43 50 | 62 15·27 | ........ | ........ | ....... | ....... |

MARITIME POSITIONS AND TIDAL DATA.

**NORTH AND EAST COASTS OF SOUTH AMERICA—Continued.**

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Argentina. | Labyrinth Head: Summit | 39 26 30 | 62 03 22 | | | | |
| | Union Bay: Indian Head | 39 57 30 | 62 07 46 | | | | |
| | San Blas Harbor: SW: end of Hog Islet | 40 32 52 | 62 09 30 | | | | |
| | San Blas Bay: Summit of Rubia Pt | 40 36 10 | 62 10 12 | | | | |
| | Rio Negro: Main Pt | 41 02 00 | 62 45 11 | 10 50 | 4 38 | 14.7 | 7.7 |
| | Bermeja Head: E. summit | 41 11 00 | 63 08 16 | | | | |
| | Port San Antonio: Point Villarino | 40 49 00 | 64 54 41 | 10 35 | 4 23 | 23.5 | 12.3 |
| | San Antonio Sierra: Summit | 41 41 10 | 65 12 29 | | | | |
| | Port San José: San Quiroga Pt | 42 14 15 | 64 27 56 | | | | |
| | Delgado Point: SE. cliff | 42 46 15 | 63 37 16 | | | | |
| | Cracker Bay: Anchorage | 42 57 00 | 64 28 20 | | | | |
| | Port Madryn: Anchorage off cave bluff | 42 45 40 | 64 59 00 | 7 05 | 0 52 | 13.2 | 6.9 |
| | Chupat River: Entrance | 43 20 45 | 65 03 36 | | | | |
| | Port St. Elena: St. Elena pen | 44 30 40 | 65 22 10 | 3 50 | 10 03 | 16.8 | 8.8 |
| | Leones Island: SE. summit | 45 04 00 | 65 36 01 | | | | |
| | Melo Port: W. pt | 45 03 00 | 65 52 30 | | | | |
| | Port Malaspina: S. pt | 45 10 10 | 66 32 36 | | | | |
| | Cape Three Points: NE. pitch | 47 06 20 | 65 51 46 | | | | |
| | Port Desire: Largest ruin | 47 45 05 | 65 54 45 | 0 00 | 6 12 | 18.3 | 9.6 |
| | Sea Bear Bay: Wells Pt | 47 57 15 | 65 45 40 | | | | |
| | Port San Julian: Sholl Pt | 49 15 20 | 67 42 30 | 10 35 | 4 23 | 29.5 | 15.4 |
| | Port Santa Cruz: Mount at entrance | 50 08 30 | 68 23 00 | 9 20 | 3 08 | 39.6 | 20.7 |
| | Coy Inlet: Height S. side of entrance | 50 58 27 | 69 09 47 | 9 00 | 2 47 | 40.0 | 20.9 |
| | Gallegos River: Observation mound | 51 33 21 | 69 00 31 | 8 40 | 2 28 | 45.6 | 23.9 |
| | Cape Virgins: SE. extreme | 52 18 35 | 68 22 12 | 8 18 | 2 06 | 38.7 | 20.2 |
| | Cape San Diego: Extreme | 54 40 35 | 65 05 53 | 4 20 | 10 33 | 9.9 | 5.2 |
| | Staten Island, Cape St. John: Lighthouse, W. pt | 54 43 24 | 63 47 00 | 4 19 | 10 32 | 7.8 | 6.0 |
| | Port Cork: Observation mark, summit | 54 45 16 | 64 03 00 | | | | |
| | Cape St. Bartholomew: Middle pt | 54 53 45 | 64 45 45 | | | | |
| | Good Success Bay: S. end of beach | 54 48 02 | 65 13 48 | | | | |
| Chile. | Lennox Cove: Bluff, N. end of beach | 55 17 00 | 66 49 00 | | | | |
| | Goree Road: Guanaco Pt | 55 19 00 | 67 10 00 | 3 50 | 10 03 | 6.7 | 5.2 |
| | Wollaston Island: Middle Cove | 55 35 30 | 67 19 00 | | | | |
| | Barneveldt Islands: Center | 55 48 54 | 66 43 48 | | | | |
| | Cape Horn: South summit, 500 ft | 55 58 41 | 67 16 15 | | | | |
| | Hermite Island: St. Martin Cove | 55 51 20 | 67 34 00 | 4 07 | 10 02 | 4.8 | 3.8 |

**WEST COAST OF SOUTH AMERICA.**

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| Chile. | False Cape Horn: S. extreme | 55 43 15 | 68 04 40 | | | | |
| | Ildefonso Island: Highest summit | 55 52 30 | 69 17 30 | | | | |
| | Diego Ramirez Island: Highest summit | 56 28 50 | 68 41 30 | 3 50 | 10 03 | 5.0 | 3.9 |
| | York Minster Rock: Summit, 800 ft | 55 24 50 | 70 01 30 | | | | |
| | Cape Desolation: S. summit | 54 45 40 | 71 36 10 | | | | |
| | Mount Skyring: Summit, 3,000 ft | 54 24 48 | 72 10 20 | | | | |
| | Noir Island: SE. extreme | 54 30 00 | 73 00 00 | 2 20 | 8 33 | 4.8 | 3.7 |
| | Landfall Island: Summit of Cape Inman | 53 18 30 | 74 18 15 | 1 50 | 8 03 | 4.7 | 3.7 |
| | Cape Deseado: Peaked summit | 52 55 30 | 74 36 30 | | | | |
| | Apostle Rocks: W. rocks | 52 46 15 | 74 46 50 | | | | |
| | Cape Pillar: N. cliff | 52 42 50 | 74 42 20 | 0 32 | 6 45 | 4.0 | 3.1 |
| | Dungeness Point: Light-house | 52 23 55 | 68 25 45 | 8 19 | 2 07 | 39.4 | 20.6 |
| | Cape Espiritu Santo: NE. cliff | 52 39 00 | 68 34 00 | 8 20 | 2 08 | 39.0 | 20.4 |
| | Catharine Point: NE. extreme | 52 32 00 | 68 45 20 | 8 24 | 2 12 | 30.0 | 15.7 |
| | Cape Possession: Light-house | 52 17 54 | 68 57 10 | 8 35 | 2 25 | 39.0 | 20.4 |
| | Cape Orange: N. extreme | 52 28 40 | 69 24 00 | | | | |
| | Delgada Point: Light-house | 52 28 00 | 69 33 00 | 8 47 | 2 40 | 39.0 | 20.4 |
| | Cape Gregory: Light-house | 52 38 18 | 70 14 16 | 9 23 | 3 20 | 21.0 | 11.0 |
| | Cape San Vicente: W. extreme | 52 46 20 | 70 25 25 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### WEST COAST OF SOUTH AMERICA—Continued.

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Elizabeth Island: NE. bluff | 52 49 18 | 70 37 51 | 10 24 | 4 24 | 8.0 | 4.2 |
| | Sandy Point: Light-house | 53 10 10 | 70 54 24 | 11 03 | 5 03 | 5.0 | 2.6 |
| | Cape St. Valentine: Summit, at extreme | 53 33 30 | 70 34 27 | ........ | ........ | ...... | ...... |
| | Port Famine: Observatory | 53 38 12 | 70 58 31 | 11 58 | 5 58 | 6.0 | 3.1 |
| | Cape San Isidro: Extreme | 53 47 00 | 70 55 03 | 12 21 | 6 21 | 8.0 | 4.2 |
| | Cape Froward: Summit of bluff | 53 53 43 | 71 17 15 | 0 28 | 6 53 | 7.0 | 3.7 |
| | Mount Pond: Summit | 53 51 45 | 71 55 30 | ........ | ........ | ...... | ...... |
| | Port Gallant: Wigwam Pt | 53 41 45 | 71 59 41 | 1 20 | 7 40 | 8.0 | 4.2 |
| | Charles Island: White rock near NW. end | 53 43 57 | 72 04 45 | ........ | ........ | ...... | ...... |
| | Rupert Island: Summit | 53 42 00 | 72 10 42 | ........ | ........ | ...... | ...... |
| | Mussel Bay: Entrance | 53 37 10 | 72 19 30 | ........ | ........ | ...... | ...... |
| | Tilly Bay: Sarah I | 53 34 20 | 72 27 10 | ........ | ........ | ...... | ...... |
| | Borja Bay: Bluff on W. shore | 53 31 45 | 72 34 15 | 1 54 | 8 11 | 5.5 | 2.9 |
| | Cape Quad: Extreme | 53 32 10 | 72 32 25 | ........ | ........ | ...... | ...... |
| | Barcelo Bay: Entrance | 53 30 50 | 72 38 00 | ........ | ........ | ...... | ...... |
| | Swallow Bay: Shag I | 53 30 05 | 72 47 30 | 1 53 | 8 08 | 5.0 | 3.9 |
| | Cape Notch: Extreme | 53 25 00 | 72 47 55 | ........ | ........ | ...... | ...... |
| | Playa Parda Cove: Summit of Shelter I | 53 18 45 | 73 00 30 | 1 31 | 7 44 | 4.5 | 3.5 |
| | Pollard Cove: Entrance | 53 15 30 | 73 12 05 | ........ | ........ | ...... | ...... |
| | Port Angosto: Hay Pt | 53 13 40 | 73 21 30 | 1 09 | 7 21 | 4.0 | 3.1 |
| | St. Anne Island: Central summit | 53 06 30 | 73 15 30 | ........ | ........ | ...... | ...... |
| | Half Port Bay: Point | 53 11 40 | 73 17 45 | ........ | ........ | ...... | ...... |
| | Upright Port: Entrance | 53 06 35 | 73 16 15 | ........ | ........ | ...... | ...... |
| | Port Tamar: Mouat Islet | 52 55 46 | 73 44 28 | 0 55 | 7 07 | 6.0 | 4.6 |
| Chile. | Port Churruca: Summit of Blanca Pen | 53 01 00 | 73 59 33 | ........ | ........ | ...... | ...... |
| | Valentine Harbor: Observation mount | 52 55 00 | 74 17 45 | ........ | ........ | ...... | ...... |
| | Cape Parker: W. summit | 52 42 00 | 74 13 30 | ........ | ........ | ...... | ...... |
| | Mercy Harbor: Summit of Battle I | 52 44 58 | 74 38 14 | ........ | ........ | ...... | ...... |
| | Mayne Harbor: Observation spot | 51 18 29 | 74 04 00 | ........ | ........ | ...... | ...... |
| | Port Grappler: Observation spot | 49 25 19 | 74 17 39 | ........ | ........ | ...... | ...... |
| | Port Riofrio: Vitalia I | 49 12 40 | 74 23 27 | ........ | ........ | ...... | ...... |
| | Eden Harbor: Observation spot | 49 07 30 | 74 25 10 | ........ | ........ | ...... | ...... |
| | Halt Bay: Observation islet | 48 54 20 | 74 20 55 | ........ | ........ | ...... | ...... |
| | Westminster Hall Islet: E. summit | 52 37 18 | 74 23 10 | ........ | ........ | ...... | ...... |
| | Evangelistas Island: Light-house | 52 24 00 | 75 06 00 | 0 55 | 7 08 | 4.4 | 3.4 |
| | Cape Victory: Extreme | 52 16 10 | 74 55 00 | ........ | ........ | ...... | ...... |
| | Cape Isabel: W. extreme | 51 51 50 | 75 13 20 | ........ | ........ | ...... | ...... |
| | Cape Santiago: Summit | 50 42 00 | 75 27 45 | ........ | ........ | ...... | ...... |
| | Molyneux Sound: Romalo I | 50 17 20 | 74 51 30 | ........ | ........ | ...... | ...... |
| | Cape Tres Puntas: Summit, 2,000 ft | 50 02 00 | 75 22 00 | ........ | ........ | ...... | ...... |
| | Port Henry: Observation spot | 50 00 18 | 75 13 20 | 0 30 | 6 45 | 4.5 | 3.5 |
| | Mount Corso: SW. summit | 49 48 00 | 75 34 00 | ........ | ........ | ...... | ...... |
| | Rock of Dundee: Summit | 48 06 15 | 75 40 30 | ........ | ........ | ...... | ...... |
| | Santa Barbara Port: N. extreme obs. pt. | 48 02 20 | 75 28 20 | 0 15 | 6 30 | 5.3 | 4.1 |
| | Guaineco Islands: Speedwell Bay, hill, NE. pt | 47 39 30 | 75 10 00 | ........ | ........ | ...... | ...... |
| | Port Otway: Observation spot | 46 49 31 | 75 18 20 | 0 10 | 6 25 | 5.3 | 4.1 |
| | Cape Tres Montes: Extreme | 46 58 57 | 75 25 30 | ........ | ........ | ...... | ...... |
| | Cape Raper: Rock close to cape | 46 49 10 | 75 37 55 | ........ | ........ | ...... | ...... |
| | Christmas Cove: SE. extreme | 46 35 00 | 75 31 30 | ........ | ........ | ...... | ...... |
| | Hellyer Rocks: Middle | 46 04 00 | 75 12 00 | ........ | ........ | ...... | ...... |
| | Cape Taytao: W. extreme | 45 53 20 | 75 06 00 | 0 00 | 6 13 | 4.4 | 3.4 |
| | Socorro Island: S. extreme | 44 55 50 | 75 08 45 | ........ | ........ | ...... | ...... |
| | Mayne Mountain: Summit, 2,080 ft | 44 09 00 | 74 07 45 | ........ | ........ | ...... | ...... |
| | Port Low: Observation islet | 43 48 30 | 73 59 35 | 12 20 | 6 10 | 6.2 | 4.8 |
| | Huafo Island: S. extreme | 43 41 50 | 74 42 00 | 12 10 | 6 00 | 6.1 | 3.1 |
| | Port San Pedro: Cove on S. shore | 43 19 35 | 73 41 50 | ........ | ........ | ...... | ...... |
| | Cape Quilan: SW. extreme | 43 17 10 | 74 22 00 | ........ | ........ | ...... | ...... |
| | Corcovado Volcano: Summit, 7,510 ft | 43 11 20 | 72 44 40 | ........ | ........ | ...... | ...... |
| | Minchinmadiva Volcano: S. summit, 8,000 feet | 42 48 00 | 72 30 30 | ........ | ........ | ...... | ...... |
| | Castro: E. end of town | 42 27 45 | 73 45 20 | 0 01 | 6 21 | 18.0 | 9.1 |

MARITIME POSITIONS AND TIDAL DATA.

## WEST COAST OF SOUTH AMERICA—Continued.

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Dalcahue: Chapel | 42 23 00 | 73 36 00 | | | | |
| | Oscuro head: Observation pt | 42 04 00 | 73 25 00 | | | | |
| | Coman Inlet: Olvidada I | 42 03 00 | 72 45 00 | | | | |
| | Port Calbuco: La Picuta | 41 46 08 | 73 07 15 | 1 10 | 7 35 | 14.8 | 7.5 |
| | San Carlos de Ancud: Light-house | 41 46 40 | 73 52 54 | 0 04 | 6 20 | 5.9 | 3.0 |
| | Condor Cove: Landing | 40 46 19 | 73 51 00 | | | | |
| | Ranu Cove: Anchorage | 40 43 18 | 73 49 50 | | | | |
| | Muilcalpue Cove: Landing place | 40 35 52 | 73 45 00 | | | | |
| | Milagro Cove: Landing place | 40 21 04 | 73 45 20 | | | | |
| | Laruehuapi Cove: Landing place | 40 11 47 | 73 41 50 | 0 00 | 6 13 | 7.2 | 3.7 |
| | Valdivia: Niebla Fort light | 39 51 37 | 73 26 25 | 10 25 | 4 13 | 5.6 | 2.8 |
| | Queule Bay: Choros Pt | 39 23 00 | 73 14 00 | 10 18 | 4 05 | 4.9 | 2.5 |
| | Mocha Island: Light-house | 38 21 22 | 73 58 06 | 10 20 | 5 07 | 3.3 | 1.7 |
| | Lebu River: Tucapel Head | 37 35 20 | 73 39 55 | 10 15 | 4 02 | 4.9 | 2.5 |
| | Yañez Port: Anchorage | 37 22 30 | 73 40 00 | 10 10 | 3 55 | 5.3 | 2.7 |
| | Lota: Light-house | 37 05 20 | 73 11 13 | 10 05 | 3 50 | 4.9 | 2.5 |
| | Santa Maria Island: Light-house | 36 59 07 | 73 32 30 | 10 10 | 3 55 | 6.0 | 3.0 |
| | Talcahuano: Fort Galvez | 36 42 00 | 73 07 27 | 10 04 | 3 51 | 5.3 | 2.7 |
| | Light on Quinquina I | 36 36 45 | 73 02 49 | 10 05 | 3 53 | 5.0 | 2.5 |
| | Llico: Village | 34 46 02 | 72 06 12 | 9 57 | 3 48 | 4.1 | 2.1 |
| | Port San Antonio: Village | 33 34 13 | 71 38 00 | 9 44 | 3 34 | 4.0 | 2.0 |
| | Aconcagua Mountain: Summit | 33 38 30 | 69 56 30 | | | | |
| | Santiago: Observatory | 33 26 42 | 70 41 32 | | | | |
| Chile. | Valparaiso: Playa Ancha Pt. light | 33 01 08 | 71 38 52 | 9 37 | 3 26 | 3.9 | 2.0 |
| | Site of Fort San Antonio | 33 01 52 | 71 38 42 | | | | |
| | Quintero Point: Summit | 32 46 00 | 71 32 56 | 9 35 | 3 25 | 4.1 | 2.1 |
| | Pichidanque: SE. pt. of island | 32 07 55 | 71 33 22 | 9 30 | 3 20 | 3.9 | 2.0 |
| | Tablas Point: SW. extreme | 31 51 45 | 71 34 51 | 9 26 | 3 16 | 4.2 | 2.1 |
| | Chuapa River: S. entrance pt | 31 39 30 | 71 35 20 | | | | |
| | Maitencillo Cove: N. head | 31 17 05 | 71 39 21 | | | | |
| | Talinay Mount: Summit | 30 50 45 | 71 39 00 | | | | |
| | Lengua de Vaca: Light-house | 30 14 00 | 71 39 00 | | | | |
| | Port Tongoi: Obs. spot. W. of village | 30 15 14 | 71 31 09 | 9 15 | 3 05 | 4.1 | 2.1 |
| | Coquimbo: Tortuga Pt. light | 29 56 15 | 71 21 00 | 8 58 | 2 48 | 4.9 | 2.5 |
| | Smelting works, N. of town | 29 56 24 | 71 21 53 | | | | |
| | N. islet | 29 55 10 | 71 22 21 | | | | |
| | Pajaros Islets: Light-house | 29 34 40 | 71 33 20 | | | | |
| | Choros Islands: SW. pt. of largest id | 29 15 45 | 71 34 38 | | | | |
| | Chañaral Island: Light-house | 29 00 50 | 71 36 40 | | | | |
| | Huasco: Light on mole | 28 27 20 | 71 15 45 | 8 23 | 2 10 | 4.9 | 2.5 |
| | Herradura de Carrizal: Landing place | 28 05 45 | 71 12 48 | 8 50 | 2 38 | 4.9 | 2.5 |
| | Port Carrizal: Middle Point | 28 04 30 | 71 11 32 | | | | |
| | Matamoras Cove: Outer pt. S. side | 27 54 10 | 71 09 38 | | | | |
| | Salado Bay: Summit of Cachos Pt | 27 39 20 | 71 03 26 | | | | |
| | Copiapo: Landing place | 27 20 00 | 70 58 45 | 8 21 | 2 08 | 5.0 | 2.5 |
| | Caldera: Light-house | 27 03 15 | 70 52 54 | 8 50 | 2 37 | 4.9 | 2.5 |
| | Light on mole head | 27 03 15 | 70 53 45 | | | | |
| | Cabeza de Vaca Point: Extreme | 26 51 05 | 70 51 55 | | | | |
| | Flamenco: SE. corner of bay | 26 34 30 | 70 44 25 | 9 00 | 2 47 | 5.0 | 2.5 |
| | Chañaral Port: Observation pt | 26 20 00 | 70 37 25 | 9 05 | 2 52 | 4.9 | 2.5 |
| | St. Felix I.: Peterborough Cathedral Rock | 26 16 12 | 80 11 43 | | | | |
| | Pan de Azucar Island: Summit | 26 09 15 | 70 43 57 | | | | |
| | Lavata: Cove near SW. pt | 25 39 30 | 70 44 03 | 9 10 | 2 57 | 5.0 | 2.5 |
| | San Pedro Point: Summit | 25 31 00 | 70 41 18 | | | | |
| | Port Taltal: Light-house | 25 25 20 | 70 34 10 | 9 20 | 3 07 | 4.9 | 2.5 |
| | Grande Point: Outer summit | 25 07 00 | 70 30 16 | 9 35 | 3 22 | 5.0 | 2.5 |
| | Paposo Road: Huanillo Pt | 25 05 25 | 70 29 50 | 9 30 | 3 17 | 4.9 | 2.5 |
| | Reyes Head: Extreme pitch | 24 34 30 | 70 36 29 | | | | |
| | Cobre Bay: Pt. W. of village | 24 15 00 | 70 33 00 | | | | |
| | Jara Head: Summit | 23 53 00 | 70 32 28 | | | | |
| | Antofagasta: Light-house | 23 38 50 | 70 25 18 | 9 05 | 2 52 | 4.7 | 2.4 |
| | Chimba Bay: E. pt. of large island | 23 33 05 | 70 26 55 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### WEST COAST OF SOUTH AMERICA—Continued.

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Chile.** | Moreno Mountain: Summit | 23 28 30 | 70 34 56 | | | | |
| | Constitution Cove: Shingle pt. of island. | 23 26 42 | 70 37 11 | | | | |
| | Mexillones Mount: Summit | 23 06 30 | 70 31 39 | 9 35 | 3 22 | 3.9 | 2.0 |
| | Port Cobija: Landing place | 22 34 00 | 70 17 42 | 9 44 | 3 31 | 4.0 | 2.0 |
| | Tocopilla: Extremity Point | 22 06 00 | 70 13 40 | 8 55 | 2 42 | 4.8 | 2.4 |
| | San Francisco Head: W. pitch | 21 55 50 | 70 11 17 | | | | |
| | Loa River: Mouth | 21 28 00 | 70 02 45 | | | | |
| | Lobos Point: Outward pitch | 21 05 30 | 70 12 12 | 9 00 | 2 47 | 4.9 | 2.5 |
| | Pabellon de Pica: Summit | 20 57 40 | 70 10 26 | | | | |
| | Patache Point: Extreme | 20 51 05 | 70 14 40 | | | | |
| | Iquique: Light-house | 20 12 30 | 70 11 20 | 8 35 | 2 22 | 5.0 | 2.5 |
| | Mexillon Bay: Landing place | 19 05 01 | 70 10 30 | | | | |
| | Pisagua: Pichalo Pt., extreme | 19 36 30 | 70 15 21 | 8 32 | 2 20 | 5.0 | 2.5 |
| | Gorda Point: W. low extreme | 19 19 00 | 70 17 50 | | | | |
| | Lobos Point: Summit | 18 45 40 | 70 21 50 | | | | |
| | Arica: Iron church | 18 28 43 | 70 20 00 | 7 49 | 1 37 | 5.6 | 2.8 |
| | Schama Mount: Highest summit | 17 58 35 | 70 52 31 | | | | |
| **Peru.** | Coles Point: Extreme | 17 42 00 | 71 22 31 | | | | |
| | Ilo: Mouth of rivulet | 17 37 00 | 71 20 01 | 7 55 | 1 43 | 5.3 | 2.7 |
| | Port Mollendo: Light-house | 17 01 00 | 72 02 53 | | | | |
| | Islay: Custom-house | 17 00 00 | 72 07 16 | 7 39 | 1 27 | 6.2 | 3.1 |
| | Quilca: W. head of cove | 16 42 20 | 72 27 16 | | | | |
| | Pescadores Point: SW. extreme | 16 23 50 | 73 16 41 | | | | |
| | Atico: E. cove | 16 13 30 | 73 41 31 | | | | |
| | Chala Point: Extreme | 15 48 00 | 74 27 16 | | | | |
| | Lomas: Flagstaff on pt | 15 33 15 | 74 51 01 | | | | |
| | San Juan Port: Needle Hummock | 15 20 56 | 75 09 36 | 6 47 | 0 35 | 3.9 | 2.0 |
| | Nasca Point: Summit | 14 57 00 | 75 30 46 | | | | |
| | Mesa de Doña Maria: Central summit | 14 41 00 | 75 49 56 | | | | |
| | Carreta Mount: Summit | 14 09 50 | 76 16 36 | | | | |
| | San Gullan Island: N. summit | 13 50 00 | 76 27 31 | | | | |
| | Paraca Bay: N. extreme of W. pt | 13 48 00 | 76 18 31 | | | | |
| | Pisco: Light-house | 13 45 00 | 76 10 00 | 6 16 | 0 04 | 3.8 | 1.9 |
| | Chincha Islands: Boat slip, E. side N. id. | 13 38 20 | 76 24 15 | | | | |
| | Frayles Point: Extreme | 13 01 00 | 76 31 06 | | | | |
| | Asia Rock: Summit | 12 48 00 | 76 38 11 | | | | |
| | Chilca Point: SW. pitch | 12 31 00 | 76 48 56 | | | | |
| | Morro Solar: Summit | 12 11 30 | 77 02 31 | | | | |
| | San Lorenzo Island: Light-house | 12 04 03 | 77 15 44 | | | | |
| | Callao: Palominos Rock Light | 12 08 15 | 77 14 45 | 5 47 | 12 00 | 3.5 | 1.8 |
| | Pescadores Islands: Summit of largest | 11 47 10 | 77 16 11 | | | | |
| | Pelado Island: Summit | 11 27 10 | 77 50 04 | | | | |
| | Supé: W. end of village | 10 49 45 | 77 43 42 | | | | |
| | Huarmey: W. end of sandy beach | 10 06 15 | 78 10 02 | 5 08 | 11 21 | 2.1 | 1.1 |
| | Colina Redonda: Summit | 9 38 35 | 78 21 33 | | | | |
| | Samanco Bay: Cross Pt | 9 15 30 | 78 30 03 | | | | |
| | Chimbote: Village, N. part | 9 04 40 | 78 35 57 | 4 50 | 11 03 | 2.0 | 1.0 |
| | Chao Islet: Center | 8 46 30 | 78 45 16 | | | | |
| | Guanape Islands: Summit of highest | 8 34 50 | 78 56 53 | | | | |
| | Huanchaco Point: SW. extreme | 8 05 40 | 79 06 46 | | | | |
| | Malabrigo Bay: Rocks | 7 42 40 | 79 26 00 | 4 19 | 10 32 | 2.1 | 1.1 |
| | Pacasmayo: Light-house | 7 23 40 | 79 33 15 | | | | |
| | Eten Head: Light-house | 6 55 50 | 79 51 30 | 4 04 | 10 17 | 2.5 | 1.3 |
| | Lambayeque: Beach opposite | 6 46 00 | 79 57 55 | | | | |
| | Lobos de Afuera Island: Cove on E. side. | 6 46 45 | 80 42 54 | | | | |
| | Lobos de Tierra Island: Central summit. | 6 26 45 | 80 51 56 | | | | |
| | Aguja Point: W. cliff summit | 5 55 30 | 81 09 19 | | | | |
| | Paita, Saddle: S. summit | 5 12 00 | 81 05 36 | | | | |
| | Paita: Light-house | 5 05 00 | 81 07 03 | 3 20 | 9 33 | 3.5 | 1.8 |
| | Parinas Point: Extreme | 4 40 50 | 81 17 01 | | | | |
| | Cape Blanco: Under middle of high cliff. | 4 16 40 | 81 12 01 | | | | |
| | Tumbez: Malpelo Pt | 3 30 42 | 80 28 12 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

## WEST COAST OF SOUTH AMERICA—Continued.

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | o ′ ″ | o ′ ″ | h. m. | h. m. | ft. | ft. |
| Ecuador. | Guayaquil River: Light on Santa Clara I. | 3 10 40 | 80 25 29 | 4 00 | 10 13 | 10.0 | 5.1 |
| | Guayaquil, Concejo: S. pt. of city ........ | 2 12 24 | 79 52 19 | 7 00 | 1 00 | 11.0 | 5.6 |
| | Puna: Mandinga Pt. light............. | 2 44 30 | 79 53 45 | | | | |
| | Point Santa Elena: Veintemilla light.... | 2 12 00 | 80 59 00 | 3 00 | 9 13 | 7.9 | 4.0 |
| | Plata Isle: E. pt.......... | 1 16 55 | 81 03 55 | | | | |
| | Cape San Lorenzo: Marlingspike Rock.. | 1 03 30 | 80 55 55 | | | | |
| | Manta Bay: Light-house ............... | 0 56 50 | 80 42 50 | 3 10 | 9 23 | 7.5 | 3.8 |
| | Caraques Bay: Punta Playa ............. | 0 35 25 | 80 25 24 | | | | |
| | Cape Pasado: Extreme................. | 0 21 30 | 80 30 37 | 3 15 | 9 28 | 9.9 | 5.0 |
| | | Lat. N. | | | | | |
| | Point Galera: N. extreme .............. | 0 50 10 | 80 05 40 | | | | |
| | Cape San Francisco: SW. extreme ....... | 0 40 00 | 80 07 55 | | | | |
| Colombia. | Esmeralda River: Light-house:.......... | 1 03 30 | 79 42 00 | | | | |
| | Mangles Point: S. pt. of creek entrance.. | 1 36 00 | 79 03 30 | | | | |
| | Tumaco: S. pt. of El Morro I............. | 1 49 36 | 78 45 29 | 3 35 | 9 48 | 13.2 | 7.1 |
| | Guascama Point: Extreme ............. | 2 37 10 | 78 24 24 | | | | |
| | Gorgona Island: Watering Bay......... | 2 58 10 | 78 11 16 | | | | |
| | Buenaventura: Basan Pt ............... | 3 49 27 | 77 11 45 | 6 00 | 12 13 | 13.2 | 7.1 |
| | Chirambiri Point: N. extreme .......... | 4 17 06 | 77 29 44 | | | | |
| | Cape Corrientes: SW. extreme......... | 5 28 46 | 77 33 28 | 3 40 | 9 53 | 13.1 | 7.0 |
| | Cupica Bay: Entrance to Cupica River.. | 6 41 19 | 77 30 31 | 3 30 | 9 43 | 13.3 | 7.2 |
| | Cape Marzo: SE. extreme............... | 6 49 45 | 77 40 55 | | | | |
| | Isla del Rey: Extreme of Cocos Pt...... | 8 12 30 | 78 54 40 | 3 00 | 9 13 | 15.7 | 8.5 |
| | Darien Harbor: Graham Pt ............. | 8 28 50 | 78 05 35 | | | | |
| | Flamenco Island: N. Pt............... | 8 54 30 | 79 31 15 | | | | |
| | Chepillo Island: Center................. | 8 56 32 | 79 07 55 | 3 05 | 9 18 | 16.0 | 8.7 |
| | Point Chamé: Extreme ................. | 8 39 00 | 79 41 45 | 3 30 | 9 42 | 15.0 | 8.1 |

## ISLANDS IN THE ATLANTIC OCEAN.

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | Færoe Islands, Strom Islet: Thorshaven Fort flagstaff ......... | 62 02 26 | 6 43 08 | | | | |
| | 　Halderoig Islet: Halde-roig Church ........... | 62 18 20 | 7 00 36 | | | | |
| | 　Numken Rock .......... | 61 23 00 | 6 45 30 | | | | |
| | Rockall Islet: Summit, 70 feet........... | 57 35 52 | 13 42 21 | | | | |
| Azores Islands. | Corvo Island: S. pt...................... | 39 40 07 | 31 08 00 | | | | |
| | Flores Island: Santa Cruz Fort ......... | 39 27 00 | 31 08 49 | | | | |
| | Fayal Channel: N. Magdalen Rock ...... | 38 32 09 | 28 34 00 | | | | |
| | Fayal Island, Horta: Castle of Santa Cruz. | 38 31 45 | 28 37 39 | 11 30 | 5 18 | 3.9 | 1.8 |
| | 　Caldera: summit 3,351 ft .. | 38 34 30 | 28 44 00 | | | | |
| | Pico Island: Summit...................... | 38 25 00 | 28 28 12 | | | | |
| | St. George Island: Light-house......... | 38 40 30 | 28 13 00 | | | | |
| | Graciosa Island: Santo Fort light....... | 39 05 24 | 28 00 45 | | | | |
| | Terceira Island: Monte del Brazil, near Angra ............................. | 38 38 20 | 27 13 45 | 0 20 | 6 32 | 4.4 | 2.0 |
| | St. Michael Island: Custom-house, Ponta Delgada............................. | 37 44 16 | 25 40 40 | | | | |
| | 　Pt. Arnel light ...... | 37 49 20 | 25 08 21 | 0 15 | 6 27 | 5.7 | 2.6 |
| | Santa Maria Island: Villa do Porto light. | 36 56 00 | 25 10 00 | | | | |
| | Formigas Islands: Highest rock ........ | 37 16 44 | 24 47 06 | | | | |
| Madeira Is. | Porto Santo Island: Light-house......... | 33 03 15 | 16 16 20 | 0 40 | 6 52 | 6.6 | 3.0 |
| | Desertas: Chao I., Sail Rock............ | 32 35 45 | 16 33 30 | | | | |
| | Madeira Island: Funchal light .......... | 32 37 42 | 16 55 16 | 0 35 | 6 47 | 6.6 | 3.0 |
| | 　Fora I. light-house .... | 32 43 14 | 16 39 31 | | | | |
| | 　Pico Ruivo, summit 6,056 ft ............:...... | 32 45 00 | 16 57 30 | | | | |
| | 　Pargo (W.) Pt ......... | 32 48 07 | 17 16 05 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### ISLANDS IN THE ATLANTIC OCEAN—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Salvage Islands: Light-house, Gran Salvage I ................................. | 30 08 00 | 15 54 00 | ......... | ......... | ...... | ...... |
| Canary Islands. | Alegranza Island: Delgada Pt. light .... | 29 23 50 | 13 29 31 | ......... | ......... | ...... | ...... |
| | Lanzarote Island: Port Naos light ...... | 28 57 24 | 13 33 07 | 0 50 | 7 00 | 8.5 | 3.9 |
| | Pechinguera Pt. light. | 28 50 56 | 13 52 05 | ......... | ......... | ...... | ...... |
| | Lobos Island: Martino Pt. light ......... | 28 45 25 | 13 49 13 | ......... | ......... | ...... | ...... |
| | Fuerta Ventura Island: Jandia Pt. light. | 28 03 00 | 14 31 35 | ......... | ......... | ...... | ...... |
| | Gran Canaria: Isleta Pt. light .......... | 28 10 42 | 15 25 11 | 0 40 | 6 50 | 9.3 | 4.3 |
| | Palmas light ............. | 28 07 06 | 15 24 56 | ......... | ......... | ...... | ...... |
| | Teneriffe Island: Anga Pt. light ......... | 28 35 25 | 16 08 11 | ......... | ......... | ...... | ...... |
| | Santa Cruz, Br. consulate ............... | 28 28 12 | 16 15 09 | 1 15 | 7 27 | 7.8 | 3.6 |
| | Summit of peak, 12,180 ft ...................... | 28 16 35 | 16 38 02 | ......... | ......... | ...... | ...... |
| | Gomera Island: Port Gomera........... | 28 08 00 | 17 05 55 | ......... | ......... | ...... | ...... |
| | Ferro Island: Port Hierro............... | 27 46 30 | 17 54 22 | ......... | ......... | ...... | ...... |
| | Palma Island: Light, NE. pt ........... | 28 50 06 | 17 47 01 | 0 20 | 6 30 | 8.6 | 4.0 |
| Cape Verde Islands. | San Antonio Island: Bull Pt. light...... | 17 06 50 | 24 59 15 | ......... | ......... | ...... | ...... |
| | Summit, 7,400 ft... | 17 04 00 | 25 17 00 | ......... | ......... | ...... | ...... |
| | St. Vincent Island: Porto Grande light . | 16 54 36 | 25 01 12 | 5 50 | 12 00 | 3.3 | 1.5 |
| | St. Lucia Island: N. pt............... | 16 49 00 | 24 47 08 | ......... | ......... | ...... | ...... |
| | Raza Island: E. pt................... | 16 38 00 | 24 38 08 | ......... | ......... | ...... | ...... |
| | St. Nicholas Island: Light-house......... | 16 34 00 | 24 16 00 | ......... | ......... | ...... | ...... |
| | Sal Island: N. pt. light ................. | 16 50 50 | 22 54 55 | ......... | ......... | ...... | ...... |
| | S. pt................. | 16 34 00 | 22 55 42 | 7 30 | 1 20 | 4.4 | 2.0 |
| | Boavista Island: NW. pt................ | 16 13 20 | 22 55 44 | ......... | ......... | ...... | ...... |
| | NE. pt ................ | 16 11 00 | 22 42 00 | ......... | ......... | ...... | ...... |
| | Light-house .......... | 16 09 10 | 22 57 20 | ......... | ......... | ...... | ...... |
| | Mayo Island: English Road............. | 15 07 30 | 23 12 42 | ......... | ......... | ...... | ...... |
| | St. Jago Island: Reta Pt. light......... | 15 18 06 | 23 47 06 | ......... | ......... | ...... | ...... |
| | Porto Praya, S. light... | 14 53 40 | 23 31 45 | 5 50 | 12 00 | 4.8 | 2.2 |
| | Fogo Island: N. S. da Luz, village....... | 14 53 00 | 24 30 38 | ......... | ......... | ...... | ...... |
| | Brava Island: Light-house ............. | 14 50 30 | 24 40 00 | ......... | ......... | ...... | ...... |
| Bermuda Is. | Ireland Island: Dock yard clock tower.. | 32 19 22 | 64 49 35 | 7 04 | 0 52 | 4.0 | 2.6 |
| | Bastion C................ | 32 19 37 | 64 49 15 | ......... | ......... | ...... | ...... |
| | Hamilton Island: Gibbs Hill light ...... | 32 15 05 | 64 49 40 | ......... | ......... | ...... | ...... |
| | St. Davids Island: Light-house ......... | 32 21 40 | 64 38 40 | ......... | ......... | ...... | ...... |
| | St. Paul Rocks: Summit, 64 ft.......... | 0 55 30 | 29 22 28 | ......... | ......... | ...... | ...... |
| | | Lat. S. | | | | | |
| | Rocas Reef: NW. sandy islet ........... | 3 51 30 | 33 49 29 | 5 05 | 11 18 | 10.0 | 4.6 |
| | Fernando Noronha: The Pyramid ....... | 3 50 30 | 32 25 29 | 5 00 | 11 13 | 6.0 | 2.7 |
| | Ascension Island: Fort Thornton ...... | 7 55 20 | 14 24 35 | 5 20 | 11 30 | 2.0 | 0.9 |
| | St. Helena Island: Obs. Ladder Hill .... | 15 55 00 | 5 43 03 | 3 00 | 9 10 | 2.8 | 1.3 |
| | Martin Vaz Rocks: Largest islet ........ | 20 27 42 | 28 46 57 | 3 35 | 9 48 | 3.5 | 1.6 |
| | Trinidad Island: SE. pt................ | 20 30 32 | 29 14 56 | 3 40 | 9 53 | 4.0 | 1.8 |
| | Inaccessible Island: Center............ | 37 19 00 | 12 23 00 | ......... | ......... | ...... | ...... |
| | Tristan d'Acunha Islands: NW. pt...... | 37 02 48 | 11 18 39 | 12 50 | 5 40 | 5.2 | 2.4 |
| | Gough Island: Penguin Islet ........... | 40 19 11 | 9 56 11 | ......... | ......... | ...... | ...... |
| Falkland Islands. | Port Egmont: Observation spot........ | 51 21 26 | 60 04 52 | 7 20 | 1 08 | 10.7 | 5.6 |
| | Mare Harbor: Observation spot ........ | 51 04 11 | 58 30 56 | ......... | ......... | ...... | ...... |
| | Port Louis: Flagstaff, govt. house....... | 51 32 20 | 58 08 04 | 5 31 | 11 27 | 4.3 | 2.2 |
| | Port Stanley: Governor's house ........ | 51 41 10 | 57 51 30 | ......... | ......... | ...... | ...... |
| | Cape Pembroke: Light-house .......... | 51 40 40 | 57 41 48 | ......... | ......... | ...... | ...... |
| | South Georgia Island: N. cape.......... | 54 04 45 | 38 15 00 | ......... | ......... | ...... | ...... |
| | Shag Rocks: Center .................... | 53 48 00 | 43 25 00 | ......... | ......... | ...... | ...... |
| | Sandwich Islands: S. Thulé ........... | 59 34 00 | 27 45 00 | ......... | ......... | ...... | ...... |
| | Traverse I. volcano .. | 55 57 00 | 26 33 00 | ......... | ......... | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

## ISLANDS IN THE ATLANTIC OCEAN—Continued.

| Coast. | Place. | Lat. S. | Long W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | New S. Orkney Is.: E. pt. Laurie I...... | 60 54 00 | 44 25 00 | ........ | ........ | ...... | ...... |
| | E. summit Corona-tion I., 5,397 ft ... | 60 46 00 | 45 53 00 | ........ | ........ | ...... | ...... |
| | New S. Shetland Islands, Deception Island: Port Foster ................... | 62 55 36 | 60 35 00 | ........ | ........ | ...... | ...... |
| | | | Long. E. | | | | |
| | Bouvets Island (Circumcision): Center.. | 54 16 00 | 6 14 00 | ........ | ........ | ...... | ...... |

## ATLANTIC COAST OF EUROPE.

| Coast. | Place. | Lat. N. | Long. W. | H. W. | L. W. | Spg. | Neap. |
|---|---|---|---|---|---|---|---|
| Great Britain. | Greenwich: Observatory ................ | 51 28 38 | 0 00 00 | 1 10 | 7 46 | 18.8 | 12.6 |
| | Oxford: University Observatory......... | 51 45 34 | 1 15 04 | ...... | ...... | ...... | |
| | Cambridge: Observatory ................ | 52 12 52 | 0 05 40 | ...... | ...... | ...... | |
| | | | Long. E. | | | | |
| | North Foreland: Light-house ......... | 51 22 28 | 1 26 48 | 11 24 | 5 53 | 16.8 | 8.4 |
| | South Foreland: Light-house........... | 51 08 23 | 1 22 22 | 11 09 | 5 43 | 19.8 | 10.0 |
| | Dungeness: Light-house ............... | 50 54 47 | 0 58 18 | 10 35 | 4 23 | 21.5 | 11.0 |
| | Beachy Head: Light-house............ | 50 44 15 | 0 13 00 | 11 10 | 4 58 | 19.8 | 10.1 |
| | | | Long. W. | | | | |
| | Southsea Castle: Light-house.......... | 50 46 35 | 1 05 15 | ...... | ...... | ...... | |
| | Portsmouth: Observatory .............. | 50 48 03 | 1 05 58 | 11 31 | 4 19 | 13.2 | 6.7 |
| | Southampton: Royal Pier light....... | 50 53 45 | 1 24 00 | 0 35 | 6 48 | 12.8 | 6.5 |
| | Hurst Castle: W. light............... | 50 42 07 | 1 33 04 | 11 05 | 4 53 | 12.2 | 6.2 |
| | Needles Rocks: Old light-house ....... | 50 39 42 | 1 35 25 | ...... | ...... | ...... | |
| | St. Catharine: New light-house........ | 50 34 30 | 1 17 47 | ...... | ...... | ...... | |
| | Portland: Notch Bill light ........... | 50 31 10 | 2 27 30 | 6 29 | 0 09 | 6.7 | 1.0 |
| | Start Point: Light-house ............. | 50 13 18 | 3 38 28 | 5 25 | 11 38 | 14.9 | 6.8 |
| | Plymouth: Breakwater light .......... | 50 20 02 | 4 09 27 | 5 20 | 11 33 | 15.3 | 7.0 |
| | Eddystone: Light-house .............. | 50 10 49 | 4 15 53 | ...... | ...... | ...... | |
| | Falmouth: St. Anthony Pt. light ...... | 50 08 33 | 5 01 00 | ...... | ...... | ...... | |
| | Lizard Point: W. light-house.......... | 49 57 40 | 5 12 06 | 4 45 | 10 58 | 14.2 | 6.5 |
| | Porthcurnow: SE. cor. telegraph co.'s sta. | 50 02 44 | 5 39 18 | ...... | ...... | ...... | |
| | Lands End: Longships light-house ...... | 50 04 10 | 5 44 45 | ...... | ...... | ...... | |
| | Scilly Ilands: St. Agnes light-house..... | 49 53 33 | 6 20 38 | 4 15 | 10 28 | 15.9 | 7.3 |
| | Trevose Head: Light-house ............ | 50 33 00 | 5 01 55 | ...... | ...... | ...... | |
| | Bideford: High light-house ........... | 51 04 00 | 4 12 30 | 5 45 | 11 58 | 22.7 | 11.4 |
| | Lundy Island: Light-house, N. pt ...... | 51 12 05 | 4 40 35 | 5 00 | 11 13 | 26.9 | 13.5 |
| | Bristol: Cathedral...................... | 51 27 24 | 2 35 55 | 7 00 | 0 48 | 31.3 | 15.7 |
| | Cardiff: Light-house, W. pier ......... | 51 27 48 | 3 09 42 | 6 45 | 0 33 | 36.2 | 18.1 |
| | Swansea: Light-house, W. pier........ | 51 36 50 | 3 56 00 | 5 45 | 11 58 | 27.1 | 13.6 |
| | Caldy Island: Light-house ............ | 51 37 52 | 4 40 59 | 5 40 | 11 53 | 25.3 | 12.7 |
| | St. Anns: Upper light-house .......... | 51 41 00 | 5 10 30 | 5 41 | 11 54 | 24.0 | 12.0 |
| | Smalls Rocks: Light-house............. | 51 43 15 | 5 40 15 | 5 40 | 11 53 | 20.9 | 10.5 |
| | Aberystwith: Light-house............. | 52 24 20 | 4 05 40 | 7 25 | 1 13 | 14.2 | 7.1 |
| | Bardsey Island: Light-house .......... | 52 45 00 | 4 47 50 | 7 24 | 1 12 | 14.9 | 7.5 |
| | South Stack: Light-house on rocks ..... | 53 18 30 | 4 42 00 | ...... | ...... | ...... | |
| | Holyhead: Light-house on old pier ..... | 53 18 54 | 4 37 01 | 10 00 | 3 48 | 15.8 | 7.9 |
| | Skerries Rocks: Light-house, highest I.. | 53 25 15 | 4 36 20 | ...... | ...... | ...... | |
| | Bidstone: Light-house on hill ......... | 53 24 02 | 3 10 42 | ...... | ...... | ...... | |
| | Liverpool: Rock light ................. | 53 26 38 | 3 02 27 | ...... | ...... | ...... | |
| | Observatory........ | 53 24 04 | 3 04 16 | 11 08 | 5 27 | 27.6 | 14.0 |
| | Morecambe Bay: Fleetwood high light.. | 53 55 03 | 3 00 20 | 11 00 | 4 48 | 27.4 | 13.9 |
| | Calf of Man: Upper light-house ........ | 54 03 14 | 4 49 37 | ...... | ...... | ...... | |
| | Isle of Man: Ayre Pt. light-house....... | 54 24 56 | 4 22 01 | 10 55 | 4 43 | 19.7 | 10.0 |
| | St. Bees: Light-house................. | 54 30 50 | 3 37 50 | ...... | ...... | ...... | |
| | White Haven: W. pier-head light ...... | 54 33 00 | 3 36 00 | 11 00 | 4 48 | 25.9 | 13.1 |
| | Mull of Galloway: Light-house......... | 54 38 10 | 4 51 20 | 11 05 | 4 53 | 14.8 | 8.9 |
| | Ayr, Firth of Clyde: Light-house, N. side harbor............................... | 55 28 10 | 4 38 10 | 11 40 | 5 28 | 8.7 | 5.2 |
| | Troon: Light-house, inner pier ......... | 55 32 55 | 4 41 00 | ...... | ...... | ...... | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### ATLANTIC COAST OF EUROPE—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Ardrossan: S. breakwater light | 55 38 27 | 4 49 28 | 11 35 | 5 23 | 8.8 | 5.3 |
| | Pladda Island: Light-house | 55 26 00 | 5 07 09 | | | | |
| | Glasgow: Observatory | 55 52 43 | 4 17 39 | 0 55 | 7 08 | 11.2 | 6.7 |
| | Cantyre: Light-house | 55 18 39 | 5 48 00 | 10 20 | 4 08 | 4.0 | 2.4 |
| | Rhynns of Islay: Light-house | 55 40 20 | 6 30 46 | | | | |
| | Oban: Light-house on N. pier | 56 24 50 | 5 28 20 | 5 10 | 11 22 | 12.8 | 7.7 |
| | Skerryvore Rocks: Light-house | 56 19 22 | 7 06 32 | | | | |
| | Barra Head: Light-house | 56 47 08 | 7 39 09 | 5 35 | 11 47 | 11.1 | 4.8 |
| | Glas Island: Light-house, Scalpay I | 57 51 25 | 6 38 28 | | | | |
| | Stornoway: Arnish Pt. light | 58 11 28 | 6 22 10 | 6 35 | 0 22 | 13.4 | 5.7 |
| | Butt of Lewis: Light-house | 58 30 40 | 6 16 01 | | | | |
| | Cape Wrath: Light-house | 58 37 30 | 4 59 41 | | | | |
| | Dunnet Head: Light-house | 58 40 16 | 3 22 25 | | | | |
| | Kirkwall (Orkneys): New pier-head light | 58 59 15 | 2 57 33 | 9 57 | 3 44 | 9.8 | 4.2 |
| | Startpoint (Orkneys): Light-house | 59 16 45 | 2 22 25 | | | | |
| | North Ronaldsay: Light-house | 59 23 24 | 2 22 45 | | | | |
| | Fair Isle Skroo: Light-house | 59 33 00 | 1 36 30 | 10 50 | 4 37 | 5.0 | 2.2 |
| | Sumburgh Head: Light-house | 59 51 15 | 1 16 20 | 9 35 | 3 22 | 5.2 | 2.2 |
| | Blackness (Shetland Is.): Light-house pier | 60 08 02 | 1 16 02 | | | | |
| | Lerwick (Shetland Is.): Fort | 60 09 22 | 1 08 41 | 10 20 | 4 17 | 6.0 | 2.6 |
| | Hillswickness (Shetland Is.): S. extreme | 60 27 20 | 1 29 50 | | | | |
| | Balta I. (Shetland Is.): Cairn on E. side | 60 44 25 | 0 47 30 | 9 30 | 3 17 | 6.4 | 2.7 |
| | Pentland Skerries: Upper light-house | 58 41 22 | 2 55 25 | 10 00 | 3 47 | 9.8 | 4.2 |
| | Tarbertness: Light-house | 57 51 54 | 3 46 30 | | | | |
| | Buchanness: Light-house | 57 28 15 | 1 46 22 | 0 24 | 6 36 | 11.2 | 6.1 |
| | Aberdeen (Girdleness): Light-house | 57 08 33 | 2 04 06 | 0 50 | 7 02 | 11.7 | 6.4 |
| | Buddonness: Upper light-house | 56 28 07 | 2 44 53 | 1 56 | 8 08 | 15.5 | 8.5 |
| | Bell Rock: Light-house | 56 26 03 | 2 23 06 | | | | |
| | May Island: Light-house | 56 11 00 | 2.33 22 | | | | |
| | Inch Keith Rock: Light-house | 56 02 09 | 3 08 05 | | | | |
| | Edinburgh: Observatory | 55 57 23 | 3 10 54 | 1 58 | 8 11 | 16.5 | 8.9 |
| | Berwick: Light-house | 55 46 00 | 1 59 00 | 2 08 | 8 28 | 15.0 | 7.5 |
| | Farn Island: NW. light-house | 55 37 00 | 1 39 00 | | | | |
| | Coquet Island: Light-house | 55 20 06 | 1 32 00 | | | | |
| | Tynemouth: Souter Point light-house | 54 58 10 | 1 21 30 | | | | |
| | North Shields: Light-house | 55 00 30 | 1 26 00 | 3 11 | 9 31 | 14.8 | 7.4 |
| | Sunderland: N. pier light | 54 55 07 | 1 21 30 | 3 12 | 9 32 | 14.5 | 7.3 |
| | Hartlepool: Light-house | 54 41 51 | 1 10 19 | 3 21 | 9 43 | 14.2 | 7.0 |
| | Flamborough: New light-house | 54 07 00 | 0 05 00 | 4 20 | 10 36 | 15.8 | 8.8 |
| | Humber River: Killingholme middle light | 53 39 00 | 0 12 00 | | | | |
| | | | Long. E. | | | | |
| | Spurn Head: Upper light-house | 53 34 45 | 0 07 10 | 5 16 | 11 29 | 18.5 | 10.2 |
| | Lowestoft: Light-house | 52 29 14 | 1 45 24 | 9 47 | 3 35 | 6.2 | 3.6 |
| | Orfordness: N. light-house | 52 05 00 | 1 34 30 | 11 05 | 4 53 | 7.8 | 4.5 |
| | Harwich: Landguard Pt. light | 51 56 05 | 1 19 10 | 11 56 | 5 44 | 11.2 | 6.6 |
| | | | Long. W | | | | |
| | Cape Clear: Old light-house | 51 26 02 | 9 29 03 | 3 50 | 10 03 | 8.8 | 4.4 |
| | Fastnet Rock: Light-house | 51 23 18 | 9 36 25 | | | | |
| | Mount Gabriel: Ordnance survey station | 51 33 24 | 9 32 44 | | | | |
| | Castlehaven: Light-house | 51 31 00 | 9 10 20 | 4 10 | 10 23 | 10.6 | 5.3 |
| | Mizen Hill: Ordnance survey station | 51 27 41 | 9 48 19 | | | | |
| | Bantry Bay: Roancarrig light | 51 39 10 | 9 44 49 | | | | |
| | Bull Rock: Light-house | 51 35 30 | 10 18 03 | | | | |
| | Skelligs Rocks: Light-house | 51 46 14 | 10 32 45 | | | | |
| | Valentia: Light-house | 51 56 00 | 10 19 16 | 3 30 | 9 43 | 10.8 | 4.6 |
| | Port Magee | 51 53 08 | 10 23 17 | | | | |
| | Dingle Bay: Light at entrance | 52 07 15 | 10 15 30 | 3 40 | 9 53 | 10.7 | 4.6 |
| | Blasket Islands: Westernmost rock | 52 04 30 | 10 40 00 | | | | |
| | Smerwick: Signal tower | 52 13 46 | 10 21 40 | 3 40 | 9 53 | 10.7 | 4.6 |
| | Tralee Bay: Light-house | 52 16 14 | 9 52 53 | 3 50 | 10 03 | 12.3 | 5.3 |
| | Beeves Rocks: Light-house | 52 39 00 | 9 01 18 | | | | |
| | Limerick: Cathedral | 52 40 04 | 8 37 23 | 6 00 | 0 13 | 18.7 | 8.0 |
| | Shannon River: Loop Head light | 52 33 38 | 9 55 54 | | | | |

The coast label "Great Britain" appears vertically along the left margin.

MARITIME POSITIONS AND TIDAL DATA.

**ATLANTIC COAST OF EUROPE—Continued.**

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Eeragh Island: Light-house | 53 08 55 | 9 51 30 | | | | |
| | Arran Island: Light-house | 53 07 38 | 9 42 06 | 4 15 | 10 28 | 13.4 | 5.7 |
| | Galway: Mutton I. light | 53 15 13 | 9 03 10 | 4 19 | 10 19 | 15.1 | 6.4 |
| | Golam Head: Tower | 53 13 46 | 9 46 03 | | | | |
| | Slyne Head: N. light-house | 53 23 58 | 10 14 01 | 4 16 | 10 29 | 13.2 | 5.7 |
| | Clifden Bay: Gortrumnagh Hill | 53 29 47 | 10 03 54 | | | | |
| | Tully Mountain: Ordnance survey station | 53 35 00 | 10 00 15 | | | | |
| | Inishboffin: Lyon Head light | 53 36 40 | 10 09 40 | 4 20 | 10 33 | 12.1 | 5.2 |
| | Inishturk Island: Tower | 53 42 27 | 10 06 41 | | | | |
| | Clew Bay: Inishgort light | 53 49 34 | 9 40 12 | | | | |
| | Newport: Church | 53 53 06 | 9 32 56 | | | | |
| | Clare Island: Light-house | 53 49 30 | 9 59 00 | | | | |
| | Blacksod Point: Light-house | 54 05 45 | 10 03 34 | | | | |
| | Eagle Island: W. light-house | 54 17 00 | 10 05 31 | | | | |
| | Broadhaven: Guba Cashel light | 54 16 00 | 9 53 00 | 4 50 | 11 03 | 10.4 | 4.5 |
| | Dounpatrick Head: Ordnance survey station | 54 19 36 | 9 20 41 | | | | |
| | Anghris Head: Ordnance survey station. | 54 16 33 | 8 46 02 | | | | |
| | Knocknarea: Tumulus | 54 15 30 | 8 34 25 | | | | |
| | Sligo Bay: Black Rock light | 54 18 00 | 8 37 00 | 5 10 | 11 23 | 11.4 | 5.3 |
| | Knocklane: Ordnance survey station | 54 20 50 | 8 40 14 | | | | |
| | Killybegs (Donegal Bay): St. Johns Pt. light | 54 34 08 | 8 27 33 | 5 03 | 11 16 | 11.2 | 4.8 |
| | Rathlin O'Birne Islet: Light-house | 54 39 47 | 8 49 52 | | | | |
| | Aran Island: Rinrawros light | 55 00 52 | 8 33 48 | | | | |
| | Bloody Foreland: Ordnance survey station | 55 08 13 | 8 15 38 | | | | |
| | Tory Island: Light-house | 55 16 26 | 8 15 00 | | | | |
| Great Britain. | Horn Head: Ordnance survey station | 55 12 31 | 7 57 15 | | | | |
| | Melmore Head: Tower | 55 15 14 | 7 47 12 | 5 28 | 11 41 | 11.6 | 5.3 |
| | Fanad Point: Light-house | 55 16 33 | 7 37 53 | | | | |
| | Glashedy Island: Ordnance survey station | 55 19 07 | 7 23 51 | | | | |
| | Malin Head: Tower | 55 22 50 | 7 22 22 | | | | |
| | Inishtrahull: Light-house | 55 25 55 | 7 13 37 | | | | |
| | Inishowen Head: E. light-house | 55 13 38 | 6 55 38 | | | | |
| | Moville: New Pier | 55 10 20 | 7 02 20 | 6 55 | 0 43 | 7.5 | 3.4 |
| | Londonderry: Cathedral | 54 59 40 | 7 19 25 | 7 48 | 1 35 | 8.0 | 3.6 |
| | Scalp Mountain: Ordnance survey station | 55 05 23 | 7 21 51 | | | | |
| | Benbane Head: Summit | 55 15 03 | 6 28 45 | | | | |
| | Rathlin Island: Altacarry light-house | 55 18 05 | 6 10 45 | | | | |
| | Maiden Rocks: W. light-house | 54 55 47 | 5 44 18 | 10 30 | 4 18 | 6.7 | 4.5 |
| | Lough Larne: Farres Pt. light-house | 54 51 07 | 5 47 21 | | | | |
| | Belfast Bay: Light, east side | 54 40 20 | 5 49 30 | 10 42 | 4 06 | 9.3 | 6.3 |
| | Mew Islands: Light-house | 54 41 50 | 5 31 30 | | | | |
| | Donaghadee: Light-house | 54 38 45 | 5 32 01 | 11 00 | 4 48 | 11.1 | 7.4 |
| | South Rock: Light vessel | 54 24 04 | 5 22 20 | | | | |
| | Dundrum Bay: St. John Pt. light | 54 13 30 | 5 39 30 | | | | |
| | Carlingford Lough: Haulbowline Rk. lt. | 54 01 10 | 6 04 45 | 10 45 | 4 33 | 15.8 | 9.2 |
| | Drogheda: Light-house | 53 43 00 | 6 15 00 | 10 45 | 4 33 | 11.6 | 6.8 |
| | Rockabill: Light-house | 53 35 47 | 6 00 20 | | | | |
| | Howth Peninsula: Bailey light | 53 21 40 | 6 03 06 | 10 55 | 4 43 | 12.7 | 7.5 |
| | Dublin: Observatory | 53 23 13 | 6 20 30 | | | | |
| | N. wall light | 53 20 47 | 6 13 33 | | | | |
| | Poolbeg: Light-house | 53 20 30 | 6 09 00 | 11 00 | 4 48 | 13.0 | 7.6 |
| | Kingstown: E. pier light | 53 18 10 | 6 07 30 | 10 52 | 4 27 | 10.9 | 6.4 |
| | Killiney Hill: Mapas obelisk | 53 15 52 | 6 06 37 | | | | |
| | Bray Head: Ordnance survey station | 53 10 39 | 6 04 55 | 10 30 | 4 18 | 11.8 | 6.9 |
| | Wicklow: Upper light | 52 57 54 | 6 00 08 | 10 10 | 3 58 | 8.7 | 5.1 |
| | Tara Hill: Summit | 52 41 55 | 6 13 01 | | | | |
| | Black Stairs Mountain: Ordnance survey station | 52 32 55 | 6 48 17 | | | | |
| | Tory Hill: Ordnance survey station | 52 20 53 | 7 07 31 | | | | |
| | Wexford: College | 52 20 04 | 6 28 15 | 7 05 | 0 53 | 4.9 | 2.9 |
| | Forth Mount: Ordnance survey station. | 52 18 57 | 6 33 41 | | | | |
| | Tuskar Rock: Light-house | 52 12 09 | 6 12 35 | 5 30 | 11 43 | 8.8 | 5.1 |
| | Great Saltee: S. end | 52 06 41 | 6 37 15 | | | | |
| | Waterford: Hoop Pt. light | 52 07 25 | 6 55 53 | 5 05 | 11 18 | 12.3 | 6.2 |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### ATLANTIC COAST OF EUROPE—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H.W. | L.W. | Spg. | Neap. |
| | | o    ′    ″ | o    ′    ″ | h.   m. | h.   m. | ft. | ft. |
| Great Britain. | Waterford: Cathedral.................. | 52 15 33 | 7 06 24 | ........ | ........ | ..... | ..... |
| | Great Newton Head: Metal Man Tower. | 52 08 13 | 7 10 15 | ........ | ........ | ..... | ..... |
| | Dungarvan: Ballinacourty light ...... | 52 04 27 | 7 33 05 | 5 00 | 11 13 | 12.4 | 6.2 |
| | Knockmealdown Mount: Ordnance survey station..................... | 52 13 39 | 7 54 54 | ........ | ........ | ..... | ..... |
| | Helvick Head: Ordnance survey station. | 52 03 00 | 7 32 39 | ........ | ........ | ..... | ..... |
| | Mine Head: Light-house.............. | 51 59 33 | 7 35 08 | ........ | ........ | ..... | ..... |
| | Youghal: Light-house ................ | 51 56 34 | 7 50 34 | 5 02 | 11 15 | 12.6 | 6.3 |
| | Capel Island: Tower.................. | 51 52 54 | 7 51 10 | ........ | ........ | ..... | ..... |
| | Ballycottin: Light-house ............. | 51 49 30 | 7 59 00 | 4 40 | 10 53 | 11.8 | 5.9 |
| | Cork Harbor: Haulbowline Coal Wharf. | 51 50 33 | 8 18 20 | ........ | ........ | ..... | ..... |
| | Queenstown: Roches Pt. light........ | 51 47 33 | 8 15 14 | 4 33 | 10 59 | 11.6 | 5.8 |
| | Kinsale: Light-house, S. pt............. | 51 36 11 | 8 31 58 | 4 30 | 10 43 | 11.4 | 5.7 |
| | Seven Heads: Tower.................. | 51 34 14 | 8 42 51 | 4 20 | 10 33 | 10.7 | 5.3 |
| | Galley Head: Light on summit......... | 51 31 50 | 8 57 10 | ........ | ........ | ..... | ..... |
| | Stag Rocks: Largest ................. | 51 28 05 | 9 13 27 | ........ | ........ | ..... | ..... |
| | Alderney Harbor: Old pier light........ | 49 43 00 | 2 12 00 | 6 21 | 0 16 | 17.2 | 7.6 |
| | St. Heliers: Light on Victoria Pier...... | 49 10 29 | 2 06 44 | 6 09 | 0 00 | 31.2 | 13.6 |
| | | | Long. E. | | | | |
| Norway. | Vardo: Fortress...................... | 70 22 00 | 31 07 30 | 5 40 | 11 57 | 9.0 | 5.1 |
| | Vadso: Light-house .................. | 70 04 00 | 29 45 00 | ........ | ........ | ..... | ..... |
| | North Cape: Extreme ................ | 71 11 00 | 25 40 00 | ........ | ........ | ..... | ..... |
| | Fruholm: Light-house ................ | 71 06 00 | 23 59 00 | ........ | ........ | ..... | ..... |
| | Hammerfest: Light-house............. | 70 40 15 | 23 40 00 | 2 20 | 8 40 | 8.3 | 4.7 |
| | Tromso: Observatory................. | 69 39 12 | 18 57 00 | 1 35 | 7 48 | 7.8 | 4.4 |
| | Hekkingen: Light-house.............. | 69 36 05 | 17 50 15 | ........ | ........ | ..... | ..... |
| | Andenes: Light-house ............... | 69 19 30 | 16 08 00 | 0 42 | 6 55 | 7.0 | 4.0 |
| | Lodingen (Hjertholm): Light-house .... | 68 24 40 | 16 02 30 | ........ | ........ | ..... | ..... |
| | Lofoten Island: Skraaven I. light........ | 68 09 20 | 14 40 40 | ........ | ........ | ..... | ..... |
| | Glopen light............. | 67 53 15 | 13 04 30 | ........ | ........ | ..... | ..... |
| | Gryto: Light-house................... | 67 23 15 | 13 52 30 | ........ | ........ | ..... | ..... |
| | Stot: Light-house.................... | 66 56 35 | 13 28 50 | ........ | ........ | ..... | ..... |
| | Trænen: Soe Islet light .............. | 66 25 50 | 11 59 50 | 11 35 | 5 23 | 6.9 | 3.3 |
| | Bronnosund: Light-house............. | 65 28 40 | 12 13 30 | ........ | ........ | ..... | ..... |
| | Villa: Light-house................... | 64 32 55 | 10 42 10 | ........ | ........ | ..... | ..... |
| | Halten Island: Light-house .......... | 64 10 25 | 9 24 50 | ........ | ........ | ..... | ..... |
| | Koppem ............................ | 63 48 25 | 9 44 45 | ........ | ........ | ..... | ..... |
| | Agdenes: Light-house ............... | 63 38 45 | 9 45 20 | ........ | ........ | ..... | ..... |
| | Trondheim: Mumkholmen flagstaff ..... | 63 27 04 | 10 23 30 | 11 18 | 5 04 | 8.4 | 4.1 |
| | Grip: Church ....................... | 63 13 11 | 7 36 05 | ........ | ........ | ..... | ..... |
| | Christiansund: Storvaden............. | 63 07 01 | 7 43 35 | 11 00 | 4 48 | 5.0 | 2.9 |
| | Freikallen ......................... | 63 03 04 | 7 46 04 | ........ | ........ | ..... | ..... |
| | Hestskjaer: Light-house............. | 63 05 00 | 7 29 55 | ........ | ........ | ..... | ..... |
| | Stemshesten....................... | 62 58 49 | 7 12 32 | ........ | ........ | ..... | ..... |
| | Ærstenen: Light-house .............. | 62 48 20 | 6 36 10 | ........ | ........ | ..... | ..... |
| | Svinoen Islet ...................... | 62 19 38 | 5 16 25 | ........ | ........ | ..... | ..... |
| | Hjœrringa Mountain: Summit......... | 62 11 12 | 5 07 59 | ........ | ........ | ..... | ..... |
| | Hornelen Mountain: Summit.......... | 61 51 21 | 5 15 11 | ........ | ........ | ..... | ..... |
| | Batalden Island: Store .............. | 61 38 40 | 4 47 38 | ........ | ........ | ..... | ..... |
| | Kinnsund: Light-house .............. | 61 33 35 | 4 46 45 | ........ | ........ | ..... | ..... |
| | Alden............................. | 61 19 16 | 4 47 14 | ........ | ........ | ..... | ..... |
| | Helliso: Light-house................. | 60 45 05 | 4 42 55 | ........ | ........ | ..... | ..... |
| | Bergen: Cathedral................... | 60 23 37 | 5 20 15 | 10 15 | 3 55 | 4.1 | 2.1 |
| | Lorstakken Mountain: Summit........ | 60 21 39 | 5 19 35 | ........ | ........ | ..... | ..... |
| | Marstenen Islet: Light-house.......... | 60 07 50 | 5 01 00 | ........ | ........ | ..... | ..... |
| | Furen Islet........................ | 59 57 44 | 5 03 30 | ........ | ........ | ..... | ..... |
| | Ulsire: Light-house ................. | 59 18 20 | 4 52 35 | ........ | ........ | ..... | ..... |
| | Hvidingso: Light-house.............. | 59 03 10 | 5 24 20 | ........ | ........ | ..... | ..... |
| | Port Stavanger: Light-house .......... | 58 58 30 | 5 45 20 | 9 43 | 3 40 | 1.9 | 0.8 |
| | Obristadbrœkke: Light-house ........ | 58 39 25 | 5 33 35 | ........ | ........ | ..... | ..... |
| | Synesvarde Mountain: Summit........ | 58 36 56 | 5 49 08 | ........ | ........ | ..... | ..... |
| | Kompas Mountain: Summit........... | 58 25 51 | 5 58 49 | ........ | ........ | ..... | ..... |
| | Lister: Light-house.................. | 58 06 25 | 6 34 20 | ........ | ........ | ..... | ..... |
| | Lindesnes: Light-house .............. | 57 58 55 | 7 03 ˙10 | ........ | ........ | ..... | ..... |
| | Ryvingen Island: Light-house......... | 57 58 00 | 7 29 50 | ........ | ........ | ..... | ..... |
| | Christianssand: Odderoen light........ | 58 07 50 | 8 00 30 | 4 16 | 10 15 | 1.1 | 0.5 |

MARITIME POSITIONS AND TIDAL DATA.

**ATLANTIC COAST OF EUROPE—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Norway. | Okso: Light-house | 58 04 15 | 8 03 30 | ...... | ...... | ...... | ...... |
| | Hamberg: Mill | 58 15 02 | 8 31 36 | | | | |
| | Arendal Inlet: Inner Torungerne light | 58 24 40 | 8 47 55 | 4 17 | 10 10 | 1.0 | 0.7 |
| | Jomfruland: Light-house | 58 51 50 | 9 36 15 | ........ | ........ | | |
| | Langotangen: Light-house | 58 59 25 | 9 45 50 | | | | |
| | Langesund: Church | 59 00 01 | 9 45 14 | | | | |
| | Frederiksværn: Lookout tower | 58 59 34 | 10 03 28 | 4 34 | 10 00 | 1.3 | 1.0 |
| | Svenor: Light-house | 58 58 05 | 10 09 26 | ........ | ........ | | |
| | Færder Islet: Light-house | 59 01 35 | 10 31 55 | | | | |
| | Fulehuk: Light-house | 59 10 30 | 10 36 25 | | | | |
| | Basto: Light-house | 59 23 10 | 10 32 45 | | | | |
| | Horten: Church | 59 25 34 | 10 29 52 | | | | |
| | Holmestrand: Church | 59 29 23 | 10 19 15 | | | | |
| | Drobak: Church | 59 39 52 | 10 38 08 | | | | |
| | Oscarsberg: Fort flagstaff | 59 40 21 | 10 36 55 | ........ | | | |
| | Christiania: Observatory | 59 54 44 | 10 43 35 | 5 22 | 10 37 | 1.2 | 0.9 |
| | Stromtangen (Torgauten): Light-house | 59 09 00 | 10 50 15 | ........ | ........ | | |
| | Fredriksten: Fort clock tower | 59 07 08 | 11 24 09 | | | | |
| | Torbjornskjær: Light-house | 58 59 45 | 10 47 20 | | | | |
| | Koster: Light-house | 58 54 05 | 11 00 45 | | | | |
| Sweden. | Stromstad: Steeple | 58 56 24 | 11 10 28 | | | | |
| | Nord Koster Islands: Light-house | 58 54 12 | 11 00 36 | ........ | | | |
| | Wadero Island: Light-house | 58 32 45 | 11 02 16 | | | | |
| | Hollo Island: Light-house | 58 20 12 | 11 13 24 | | | | |
| | Paternoster Rocks: Light-house | 57 53 49 | 11 28 04 | | | | |
| | Gottenburg: Signal station | 57 40 58 | 11 53 54 | ........ | | | |
| | Nidingen Islet: Light-house | 57 18 15 | 11 54 16 | | | | |
| | Warberg: Castle tower | 57 06 26 | 12 14 32 | | | | |
| | Falkenberg: Church | 56 54 08 | 12 29 48 | ........ | | | |
| | Halmstad: Palace | 56 40 21 | 12 51 38 | | | | |
| | Engelholm: Church | 56 14 40 | 12 51 47 | | | | |
| | Kullen Point: Light-house | 56 18 06 | 12 27 11 | | | | |
| | Helsingborg: Light-house | 56 02 37 | 12 41 30 | ........ | | | |
| | Landskrona: Light-house | 55 52 00 | 12 49 48 | | | | |
| | Malmo: Light-house | 55 36 47 | 12 59 49 | | | | |
| | Falsterbo: Light-house | 55 23 00 | 12 49 02 | ........ | | | |
| | Trelleborg: Light-house | 55 22 00 | 13 09 20 | | | | |
| | Ystad: Light-house | 55 25 42 | 13 49 38 | | | | |
| | Sandhammaren: Light-house | 55 22 58 | 14 11 10 | | | | |
| | Hano Island: Light-house | 56 00 54 | 14 50 57 | | | | |
| | Karlshamn: Light-house | 56 10 04 | 14 52 02 | | | | |
| | Karlskrona: Stumholm Tower | 56 09 45 | 15 36 05 | | | | |
| | Oland Island: Light on S. pt | 56 11 50 | 16 24 04 | | | | |
| | Gottland Island: Hoburg light, S. pt | 56 55 18 | 18 11 06 | | | | |
| | Ostergarns light | 57 26 29 | 18 59 27 | | | | |
| | Faro Island: Holmadden light | 57 57 24 | 19 22 36 | | | | |
| | Sparo Vestervik: Granso light | 57 45 38 | 16 40 36 | | | | |
| | Haradsskar Islet: Light-house | 58 08 52 | 16 59 22 | | | | |
| | Norrkopings Inlopp: Light-house | 58 17 55 | 16 11 28 | | | | |
| | Landsort: Light-house | 58 44 26 | 17 52 09 | | | | |
| | Stockholm: Observatory | 59 20 35 | 18 03 30 | | | | |
| | Upsala: Observatory | 59 51 31 | 17 37 39 | | | | |
| | Norrtelge: Inn | 59 45 24 | 18 41 34 | | | | |
| | Soderarm: Light-house | 59 45 15 | 19 24 34 | | | | |
| | Svartklubben: Light-house | 60 10 35 | 18 49 49 | | | | |
| | Osthammar: Church | 60 15 19 | 18 22 36 | | | | |
| | Oregrund: Clock tower | 60 20 26 | 18 26 33 | | | | |
| | Djursten: Light-house | 60 22 15 | 18 24 21 | | | | |
| | Forsmark: Church | 60 22 26 | 18 09 49 | | | | |
| | Orskar Rock: Light-house | 60 31 41 | 18 22 38 | | | | |
| | Gefle: Church | 60 40 29 | 17 08 29 | | | | |
| | Eggegrund Islet: Light-house | 60 43 48 | 17 33 50 | | | | |
| | Hamrange: Church | 60 55 57 | 17 02 57 | | | | |
| | Soderhamm: Court-house | 61 18 22 | 17 04 18 | | | | |
| | Enanger: Church | 61 32 54 | 17 01 51 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### ATLANTIC COAST OF EUROPE—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Sweden. | Hudiksvalls: Court-house | 61 43 57 | 17 07 37 | | | | |
| | Gnarp: Church | 62 02 51 | 17 16 22 | | | | |
| | Sundsvall: Church | 62 23 30 | 17 19 05 | | | | |
| | Lungo: Light-house | 62 38 35 | 18 05 05 | | | | |
| | Skags Head: Light-house | 63 11 55 | 19 02 50 | | | | |
| | Holmogadd: Light-house | 63 35 34 | 20 45 35 | | | | |
| | Umea: Bredekar Light | 63 39 33 | 20 18 35 | | | | |
| | Bjuroklubb: Light-house | 64 28 50 | 21 34 45 | | | | |
| | Pitea | 65 19 10 | 21 30 00 | | | | |
| | Rodkallen: Light-house | 65 18 53 | 22 21 55 | | | | |
| | Maloren: Light-house | 65 31 30 | 23 34 00 | | | | |
| Russia. | Tornea: Light-house | 65 48 30 | 24 12 00 | | | | |
| | Uleaborg: Karlo I. light | 65 02 20 | 24 34 00 | | | | |
| | Ulko Kalla Rock: Light-house | 64 20 05 | 23 27 00 | | | | |
| | Norrsher Islet: Kvarken light | 63 14 08 | 20 37 40 | | | | |
| | Kaske: Shelgrund I. light | 62 20 06 | 21 11 24 | | | | |
| | Bierneborg: Sebsher light | 61 28 29 | 21 22 34 | | | | |
| | Nuistad: Ensher light | 60 43 10 | 21 01 00 | | | | |
| | Abo: Observatory | 60 26 57 | 22 17 03 | | | | |
| | Aland Island: Shelsher light | 60 24 45 | 19 34 00 | | | | |
| | Ekkere light | 60 13 20 | 19 31 20 | | | | |
| | Logsher light | 59 50 50 | 19 54 05 | | | | |
| | Bogsher: Beacon | 59 31 11 | 20 25 50 | | | | |
| | Ute Islet: Light-house | 59 46 30 | 21 22 00 | | | | |
| | Gange: Gange I. light | 59 46 00 | 22 58 08 | | | | |
| | Rensher: Light-house | 59 56 10 | 24 24 43 | | | | |
| | Helsingfors: Observatory | 60 09 43 | 24 57 17 | | | | |
| | Soder Skars: Light-house | 60 06 40 | 25 25 51 | | | | |
| | Kalboden Island: Light vessel | 59 58 45 | 25 37 30 | | | | |
| | Rodsher Island: Light-house | 59 58 08 | 26 41 05 | | | | |
| | Hogland Island: Lower light | 60 00 40 | 27 01 40 | | | | |
| | Upper light | 60 06 22 | 26 58 44 | | | | |
| | Sommer Island: Light-house | 60 12 31 | 27 33 46 | | | | |
| | Vieborg Bay: Nelva I. light | 60 14 43 | 27 58 36 | | | | |
| | Stirsudden: Light-house | 60 11 05 | 29 03 01 | | | | |
| | Kronstadt: Light on Frederikstadt bastion | 59 58 14 | 29 47 12 | | | | |
| | Cathedral | 59 59 44 | 29 46 07 | | | | |
| | St. Petersburg: Observatory | 59 56 30 | 30 19 22 | | | | |
| | Pulkowa: Observatory | 59 46 19 | 30 19 40 | | | | |
| | Peterhof: Pier-head light | 59 53 26 | 29 54 54 | | | | |
| | Oranienbaum: Light-house | 59 55 40 | 29 46 38 | | | | |
| | Seskar Islet: Light-house | 60 02 08 | 28 23 01 | | | | |
| | Narva: Light S. pt. of entrance | 59 28 04 | 28 03 31 | | | | |
| | Stensher Rock: Light-house | 59 49 10 | 26 23 00 | | | | |
| | Ekholm Islet: Light-house | 59 41 06 | 25 48 58 | | | | |
| | Koksher: Light-house | 59 42 00 | 25 02 37 | | | | |
| | Revel: Light N. end of W. mole | 59 27 05 | 24 46 10 | | | | |
| | Cathedral | 59 26 28 | 24 44 45 | | | | |
| | Nargen Island: Light-house | 59 36 22 | 24 31 57 | | | | |
| | Surop: W. light | 59 27 55 | 24 24 05 | | | | |
| | Baltic Port: Light-house | 59 21 30 | 24 04 30 | | | | |
| | Odenskholm Island: Light-house | 59 18 06 | 23 23 15 | | | | |
| | Takhkona Point: Light-house | 59 05 25 | 22 36 15 | | | | |
| | Dago Island: Dagerort light | 58 55 02 | 22 11 36 | | | | |
| | Filzand Island: Light-house | 58 23 02 | 21 49 56 | | | | |
| | Svalferort Tzerel: Light-house | 57 54 37 | 22 04 15 | | | | |
| | Kuino: Light-house | 58 05 50 | 23 59 34 | | | | |
| | Pernau: Light at S. entrance | 58 23 10 | 24 49 25 | | | | |
| | Riga: Light on Fort Kametskoi dike | 57 03 28 | 24 00 59 | | | | |
| | Cathedral | 56 56 36 | 24 08 25 | | | | |
| | Runo Island: Light-house | 57 48 02 | 23 15 00 | | | | |
| | Domesnes: Light-house | 57 48 10 | 22 39 15 | | | | |
| | Windau: Light on S. jetty | 57 24 00 | 21 34 00 | | | | |
| | Libau: Light at entrance of port | 56 31 01 | 20 59 40 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

**ATLANTIC COAST OF EUROPE—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | o  ′  ″ | o  ′  ″ | h.  m. | h.  m. | ft. | ft. |
| | Memel: Light-house | 55 43 45 | 21 06 06 | | | | |
| | Heiligen Creutz: Church tower | 54 53 47 | 20 01 25 | | | | |
| | Brusterort: Light-house | 54 57 40 | 19 59 06 | | | | |
| | Pillau: Light-house | 54 38 25 | 19 53 55 | | | | |
| | Fischausen: City-hall tower | 54 43 49 | 20 00 39 | | | | |
| | Konigsberg: Observatory | 54 42 51 | 20 29 44 | | | | |
| | Tolkemit: Church tower | 54 19 19 | 19 31 58 | | | | |
| | Elbing: Church tower | 54 09 44 | 19 23 58 | | | | |
| | Tiegenort: Church tower | 54 16 30 | 19 08 37 | | | | |
| | Danzig: Observatory | 54 21 18 | 18 39 46 | | | | |
| |       Neufahrwasser light | 54 24 28 | 18 39 59 | | | | |
| | Weichselmunde: Fortress tower | 54 23 51 | 18 41 03 | | | | |
| | Putziger Heisternest: Church tower | 54 12 16 | 18 40 35 | | | | |
| | Oxhoft: Light-house | 54 33 09 | 18 33 46 | | | | |
| | Hela: Light-house | 54 36 06 | 18 49 04 | | | | |
| | Rixhoft: Light-house | 54 49 55 | 18 20 29 | | | | |
| | Leba: Church tower | 54 45 29 | 17 33 38 | | | | |
| | Stopelmunde: Church | 54 35 16 | 16 51 35 | | | | |
| | Jershoft: Light-house | 54 32 29 | 16 32 50 | | | | |
| | Rugenwalde: St. Mary's Church | 54 25 27 | 16 24 52 | | | | |
| | Coslin: St. Mary's Church | 54 11 28 | 16 11 05 | | | | |
| | Funkenhagen: Light-house | 54 14 40 | 15 52 39 | | | | |
| | Colberg: St. Mary's Church | 51 10 40 | 15 34 44 | | | | |
| | Gross-Horst: Light-house | 54 05 47 | 15 04 06 | | | | |
| | Cammin: Cathedral tower | 53 58 29 | 14 46 36 | | | | |
| | Wollin: Church tower | 53 50 41 | 14 37 12 | | | | |
| | Stettin: N. Castle tower | 53 25 41 | 14 33 52 | | | | |
| | Swinemunde: Light-house | 53 55 03 | 14 17 19 | | | | |
| | Streckelsberg: Survey station near beacon | 54 03 08 | 14 01 17 | | | | |
| | Usedom: Church tower | 53 52 17 | 13 55 26 | | | | |
| | Lassau: Church tower | 53 56 59 | 13 51 13 | | | | |
| | Wolgast: Church tower | 54 03 18 | 13 46 51 | | | | |
| | Griefswald: St. Nicholas Church | 54 05 49 | 13 22 53 | | | | |
| Germany. | Griefswalder Oie: Light-house | 54 15 02 | 13 55 42 | | | | |
| | Granitz: Castle tower | 54 22 56 | 13 37 54 | | | | |
| | Bergen: Church tower | 54 25 08 | 13 26 11 | | | | |
| | Arkona: Light-house | 54 40 53 | 13 26 12 | | | | |
| | Stralsund: St. Mary's Church | 54 18 42 | 13 05 30 | | | | |
| | Darsserort: Light-house | 54 28 28 | 12 30 23 | | | | |
| | Wustrow: Church | 54 20 47 | 12 24 02 | | | | |
| | Ribnitz: Church tower | 54 14 42 | 12 26 04 | | | | |
| | Warnemunde: Church | 54 10 42 | 12 05 19 | | | | |
| | Rostock: St. Jacob's Church | 54 05 27 | 12 08 10 | | | | |
| | Diedrichshagen: Survey station | 54 06 32 | 11 46 04 | | | | |
| | Basdorf: Survey station | 54 08 00 | 11 41 54 | | | | |
| | Wismar: St. Nicholas Church | 53 53 50 | 11 28 09 | | | | |
| | Hohenschonberg: Survey station | 53 58 54 | 11 05 54 | | | | |
| | Travemunde: Light-house | 53 57 44 | 10 52 59 | | | | |
| | Burg: Church tower | 54 26 16 | 11 11 59 | | | | |
| | Marienleuchte: Light-house | 54 29 43 | 11 14 29 | | | | |
| | Petersdorf: Church tower | 54 28 54 | 11 04 18 | | | | |
| | Hessenstein: Flagstaff of lookout tower | 54 19 47 | 10 32 59 | | | | |
| | Schonberg: Church | 54 23 52 | 10 22 24 | | | | |
| | Bulk: Light-house | 54 27 25 | 10 12 04 | | | | |
| | Kiel: Observatory | 54 20 30 | 10 08 56 | | | | |
| | Eckemforde: Church | 54 28 25 | 9 50 23 | | | | |
| | Schleswig: Cathedral | 54 30 55 | 9 34 23 | | | | |
| | Kappeln: Church | 54 39 48 | 9 56 13 | | | | |
| | Flensberg: Church | 54 47 05 | 9 26 20 | | | | |
| | Duppel: Survey station | 54 54 28 | 9 45 35 | | | | |
| | Schleimunde: Light-house | 54 40 23 | 10 02 23 | | | | |
| | Augustenburg: Church | 54 56 48 | 9 52 20 | | | | |
| | Hugeberg: Survey station | 54 58 05 | 9 58 41 | | | | |
| | Apenrade: Church | 55 02 46 | 9 25 18 | | | | |
| | Skoorgaarde: Survey station | 55 03 52 | 9 23 35 | | | | |
| | Ballum: Church | 55 05 31 | 8 39 41 | | | | |
| | List: E. light-house | 55 03 04 | 8 26 50 | 0 20 | 6 33 | 5.2 | 3.0 |

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Germany. | Keitum: Church | 54 54 13 | 8 22 03 | ........ | ........ | ........ | ........ |
| | Fohr: St. Nicholas Church | 54 41 51 | 8 33 13 | 1 35 | 7 47 | 7.8 | 4.5 |
| | Galgenberg: Survey station | 54 41 21 | 8 33 58 | ........ | ........ | ........ | ........ |
| | Husum: Church | 54 28 43 | 9 03 21 | 2 10 | 8 23 | 10.8 | 6.2 |
| | Tonning: Church | 54 19 08 | 8 56 38 | 1 45 | 7 57 | 11.0 | 6.4 |
| | Busum: Church | 54 07 52 | 8 51 53 | 1 11 | 7 24 | 11.7 | 6.8 |
| | Helgoland: Light-house | 54 10 57 | 7 53 11 | 11 29 | 5 17 | 8.1 | 4.7 |
| | Scharhorn: Beacon | 53 57 15 | 8 24 35 | ........ | ........ | ........ | ........ |
| | Neuwerk: Light-house | 53 55 01 | 8 29 58 | ........ | ........ | ........ | ........ |
| | Cuxhaven: Light-house | 53 52 25 | 8 42 43 | 0 39 | 6 51 | 10.1 | 5.8 |
| | Stade: Church steeple | 53 36 12 | 9 28 48 | ........ | ........ | ........ | ........ |
| | Steinkirchen: Church | 53 33 43 | 9 36 40 | 4 00 | 10 13 | 8.5 | 4.9 |
| | Altona: Observatory | 53 32 45 | 9 56 35 | ........ | ........ | ........ | ........ |
| | Hamburg: Observatory | 53 33 07 | 9 58 25 | 5 00 | 11 12 | 6.1 | 3.5 |
| | Berlin: Observatory | 52 30 17 | 13 23 44 | ........ | ........ | ........ | ........ |
| | Harburg: Light-house | 53 28 30 | 9 59 37 | ........ | ........ | ........ | ........ |
| | Hohe Weg: Light-house | 53 42 50 | 8 14 48 | 0 25 | 6 38 | 10.1 | 5.7 |
| | Langwarden: Church | 53 36 20 | 8 18 30 | ........ | ........ | ........ | ........ |
| | Bremerhaven: New harbor light | 53 32 52 | 8 34 25 | 0 54 | 7 07 | 10.4 | 5.8 |
| | Minsener Sand: Light vessel | 53 46 57 | 8 04 47 | 0 10 | 6 23 | 9.5 | 5.3 |
| | Schillighorn: Light-house | 53 42 21 | 8 01 43 | ........ | ........ | ........ | ........ |
| | Wilhelmshaven: Observatory | 53 31 52 | 8 08 48 | 0 04 | 6 17 | 13.2 | 7.4 |
| | Wangeroog: Light-house | 53 47 25 | 7 54 09 | 11 27 | 5 15 | 8.0 | 4.5 |
| | Spikeroog: Church | 53 46 19 | 7 41 45 | ........ | ........ | ........ | ........ |
| | Langeoog: Belvedere | 53 45 06 | 7 35 41 | ........ | ........ | ........ | ........ |
| | Balstrum: Church | 53 43 46 | 7 22 03 | ........ | ........ | ........ | ........ |
| | Norderney: Light-house | 53 42 39 | 7 13 58 | 11 05 | 4 53 | 7.3 | 4.1 |
| | Juist: Church | 53 40 45 | 6 59 53 | ........ | ........ | ........ | ........ |
| | Emden: City Hall tower | 53 22 06 | 7 12 25 | 0 24 | 6 36 | 8.9 | 5.0 |
| Denmark. | Falster: Gjedser light | 54 33 50 | 11 58 03 | ........ | ........ | ........ | ........ |
| | Moen Island: Stege Church spire | 54 59 03 | 12 17 16 | ........ | ........ | ........ | ........ |
| | Moen light, SE. pt | 54 56 46 | 12 32 40 | ........ | ........ | ........ | ........ |
| | Prœste: Church spire | 55 07 24 | 12 03 07 | ........ | ........ | ........ | ........ |
| | Kjorge: Church spire | 55 29 44 | 12 07 36 | ........ | ........ | ........ | ........ |
| | Amager Island: Hollœnderby Ch. spire | 55 35 45 | 12 38 24 | ........ | ........ | ........ | ........ |
| | Nordse Rase light | 55 38 10 | 12 41 26 | ........ | ........ | ........ | ........ |
| | Copenhagen: New observatory | 55 41 14 | 12 34 47 | 9 33 | 3 21 | 0.6 | 0.3 |
| | Bornholm: Ronne light | 55 05 40 | 14 42 00 | ........ | ........ | ........ | ........ |
| | Christianso Island: Great tower | 55 19 19 | 15 11 39 | ........ | ........ | ........ | ........ |
| | Kronberg: High spire | 56 02 20 | 12 32 02 | ........ | ........ | ........ | ........ |
| | Nakkehooed: Upper light | 56 07 10 | 12 20 50 | ........ | ........ | ........ | ........ |
| | Hesselo Island: Light-house | 56 11 50 | 11 42 50 | ........ | ........ | ........ | ........ |
| | Anholt Island: Light-house | 56 44 16 | 11 39 15 | ........ | ........ | ........ | ........ |
| | Spodsbjerg: Light-house | 55 58 36 | 11 51 36 | ........ | ........ | ........ | ........ |
| | Roeskilde: Cathedral | 55 38 34 | 12 05 02 | ........ | ........ | ........ | ........ |
| | Nykjobing: Church tower | 55 55 30 | 11 40 29 | ........ | ........ | ........ | ........ |
| | Oddensby: Church tower | 55 57 52 | 11 24 06 | ........ | ........ | ........ | ........ |
| | Sejro Island: Sejro Point light | 55 55 09 | 11 05 07 | ........ | ........ | ........ | ........ |
| | Kallundborg: Church | 55 40 50 | 11 05 04 | ........ | ........ | ........ | ........ |
| | Omo Island: Church | 55 09 48 | 11 09 32 | ........ | ........ | ........ | ........ |
| | Vordingborg: Waldemar's tower | 55 00 26 | 11 54 59 | ........ | ........ | ........ | ........ |
| | Veiro Island: Light-house | 55 02 19 | 11 22 23 | ........ | ........ | ........ | ........ |
| | Langeland Island: Fakkebjerg light | 54 44 23 | 10 42 13 | ........ | ........ | ........ | ........ |
| | Æro Island: Church spire | 54 51 14 | 10 24 11 | ........ | ........ | ........ | ........ |
| | Lyo Island: Church tower | 55 02 34 | 10 09 16 | ........ | ........ | ........ | ........ |
| | Assens: Church tower | 55 16 09 | 9 53 50 | ........ | ........ | ........ | ........ |
| | Baago Island: Light-house | 55 17 44 | 9 48 09 | ........ | ........ | ........ | ........ |
| | Kolding: Castle tower | 55 29 31 | 9 28 40 | ........ | ........ | ........ | ........ |
| | Bogense: Church spire | 55 34 03 | 10 05 29 | ........ | ........ | ........ | ........ |
| | Nyborg: Church spire | 55 18 41 | 10 47 47 | ........ | ........ | ........ | ........ |
| | Turo Island: Church spire | 55 03 00 | 10 40 02 | ........ | ........ | ........ | ........ |
| | Svendborg: Frue Church | 55 03 37 | 10 36 48 | ........ | ........ | ........ | ........ |
| | Endelave Island: Church tower | 55 45 32 | 10 16 20 | ........ | ........ | ........ | ........ |
| | Samso Island: Koldby Church tower | 55 48 02 | 10 33 37 | ........ | ........ | ........ | ........ |
| | Horsens: Frelser Church spire | 55 51 44 | 9 51 19 | ........ | ........ | ........ | ........ |

MARITIME POSITIONS AND TIDAL DATA.

**ATLANTIC COAST OF EUROPE—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Denmark. | Tuno Island: Light-house | 55 56 58 | 10 26 51 | ........ | ........ | ........ | ........ |
| | Samsoe Island: Nordby Church tower | 55 57 06 | 10 33 00 | ........ | ........ | ........ | ........ |
| | Aarhus: Cathedral spire | 56 09 26 | 10 12 50 | ........ | ........ | ........ | ........ |
| | Hjelm Islet: Light-house | 56 08 00 | 10 48 32 | ........ | ........ | ........ | ........ |
| | Fornæs: Light-house | 56 26 36 | 10 57 40 | ........ | ........ | ........ | ........ |
| | Hals: Church tower | 56 59 54 | 10 18 53 | ........ | ........ | ........ | ........ |
| | Aalborg: St. Rudolph's Church | 57 02 54 | 9 55 22 | ........ | ........ | ........ | ........ |
| | Cape Skaw, or Skagen: Old light-house | 57 43 46 | 10 36 38 | 5 46 | 11 58 | 1.0 | 0.5 |
| | Hirtshals: Light-house | 57 35 06 | 9 56 44 | 4 18 | 10 30 | 1.2 | 0.7 |
| | Haustholm: Light-house | 57 06 50 | 8 36 10 | ........ | ........ | ........ | ........ |
| | Boobjerg: Light-house | 56 30 48 | 8 07 23 | ........ | ........ | ........ | ........ |
| | Ringkjobing: Church spire | 56 05 27 | 8 14 52 | ........ | ........ | ........ | ........ |
| | Loune: Church tower | 55 47 17 | 8 14 36 | 2 35 | 8 47 | 2.1 | 1.2 |
| | Blaabjerg: Summit, 100 ft | 55 44 50 | 8 14 43 | ........ | ........ | ........ | ........ |
| | Guldager: Church | 55 31 52 | 8 24 12 | 2 35 | 8 47 | 4.5 | 2.6 |
| | Fano Island: Nordby Church | 55 26 26 | 8 24 03 | 2 34 | 8 46 | 4.7 | 2.7 |
| | Mano Island: Church spire | 55 16 11 | 8 32 38 | ........ | ........ | ........ | ........ |
| Holland. | Niewe Diep: Time-ball station | 52 57 50 | 4 46 36 | 7 17 | 1 05 | 3.9 | 2.0 |
| | Amsterdam: W. church tower | 52 22 30 | 4 53 01 | ........ | ........ | ........ | ........ |
| | Utrecht: Observatory | 52 05 10 | 5 07 50 | ........ | ........ | ........ | ........ |
| | Leyden: Observatory | 52 09 20 | 4 29 03 | ........ | ........ | ........ | ........ |
| | The Hague: Church tower | 52 04 40 | 4 18 30 | ........ | ........ | ........ | ........ |
| | Scheveningen: Light-house | 52 06 16 | 4 15 10 | ........ | ........ | ........ | ........ |
| | Brielle: Light-house | 51 54 29 | 4 10 45 | 2 50 | 9 02 | 4.8 | 2.5 |
| | Rotterdam: Time-ball station | 51 54 30 | 4 28 50 | 3 35 | 9 47 | 6.7 | 3.5 |
| | Hellevoetsluis: Time-ball station | 51 49 19 | 4 07 40 | 2 20 | 8 32 | 5.2 | 2.8 |
| | Willemstadt: Light-house | 51 41 48 | 4 26 26 | 3 20 | 9 32 | 9.8 | 5.2 |
| | Goedereede: Light on church tower | 51 49 08 | 3 58 35 | ........ | ........ | ........ | ........ |
| | Flushing: Time-ball station | 51 26 33 | 3 35 48 | ........ | ........ | ........ | ........ |
| | Light, Westhaven bastion | 51 26 24 | 3 34 32 | 0 44 | 6 56 | 14.7 | 7.8 |
| Belgium. | Brussels: Observatory | 50 51 11 | 4 22 18 | ........ | ........ | ........ | ........ |
| | Antwerp: Observatory | 51 12 28 | 4 24 44 | 4 15 | 10 27 | 14.8 | 7.8 |
| | Notre Dame Cathedral | 51 13 17 | 4 24 12 | ........ | ........ | ........ | ........ |
| | Blankenberghe: Fort light-house | 51 18 47 | 3 06 54 | 0 05 | 6 17 | 12.5 | 6.7 |
| | Ostend: Light-house | 51 14 13 | 2 55 51 | 0 02 | 6 32 | 16.1 | 8.4 |
| | Church tower | 51 13 50 | 2 55 22 | ........ | ........ | ........ | ........ |
| | Nieuport: Templars tower | 51 07 53 | 2 45 34 | 0 10 | 6 22 | 15.7 | 8.4 |
| France. | Paris: Observatory | 48 50 11 | 2 20 14 | ........ | ........ | ........ | ........ |
| | Dunkerque: Tower | 51 02 09 | 2 22 31 | 11 58 | 5 58 | 16.8 | 8.5 |
| | Gravelines: Light on N. breakwater | 51 00 18 | 2 06 34 | 11 59 | 6 16 | 19.0 | 9.6 |
| | Calais: Light on old fort | 50 57 45 | 1 51 07 | 11 39 | 6 13 | 21.0 | 10.7 |
| | Cape Gris Nez: Light-house | 50 52 10 | 1 35 02 | 11 17 | 5 51 | 21.5 | 11.0 |
| | Boulogne, C. Alprech: Light-house | 50 41 57 | 1 33 47 | 11 18 | 5 52 | 25.2 | 12.8 |
| | Abbeville: Tower | 50 07 05 | 1 49 56 | ........ | ........ | ........ | ........ |
| | Cayeux: Light-house | 50 11 42 | 1 30 46 | ........ | ........ | ........ | ........ |
| | Dieppe: W. jetty light | 49 56 06 | 1 05 01 | 10 54 | 5 48 | 27.3 | 13.3 |
| | Ailly Point: Light-house | 49 55 04 | 0 57 35 | ........ | ........ | ........ | ........ |
| | St. Valery en Caux: Light on W. break-water | 49 52 28 | 0 42 34 | 10 29 | 5 33 | 26.8 | 13.1 |
| | Fécamp: N. jetty light | 49 46 05 | 0 22 12 | 10 06 | 5 02 | 23.3 | 11.4 |
| | Cape La Heve: S. light | 49 30 04 | 0 04 08 | ........ | ........ | ........ | ........ |
| | Havre: S. jetty light | 49 29 01 | 0 06 22 | 9 03 | 4 14 | 22.5 | 11.0 |
| | Honfleur: Hospital jetty light | 49 25 32 | 0 13 43 | ........ | ........ | ........ | ........ |
| | | | Long. W. | | | | |
| | Caen: Church tower | 49 11 14 | 0 21 10 | ........ | ........ | ........ | ........ |
| | Port Corseulles: W. jetty light | 49 20 18 | 0 27 24 | ........ | ........ | ........ | ........ |
| | Point De Ver: Light-house | 49 20 28 | 0 31 08 | ........ | ........ | ........ | ........ |
| | Cape La Hougue: Light-house | 49 34 19 | 1 16 21 | 8 13 | 2 45 | 18.5 | 8.2 |
| | Cape Barfleur: Light-house | 49 41 50 | 1 15 56 | 8 14 | 2 37 | 17.0 | 7.5 |
| | Cherbourg: Light, W. head of break-water | 49 40 29 | 1 43 44 | ........ | ........ | ........ | ........ |
| | Naval Observatory | 49 38 54 | 1 38 08 | 7 30 | 1 44 | 17.6 | 7.8 |
| | Cape La Hague: Light-house | 49 43 22 | 1 57 15 | ........ | ........ | ........ | ........ |
| | Casquets Rocks: Light on NW. rock | 49 43 17 | 2 22 41 | 6 20 | 0 15 | 15.5 | 6.9 |

## MARITIME POSITIONS AND TIDAL DATA.

### ATLANTIC COAST OF EUROPE—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| France. | Port St. Peter, Guernsey: Light on Castle Coonet Breakwater | 49 27 13 | 2 31 31 | 6 12 | 0 07 | 26.0 | 11.5 |
| | Douvres Rocks: Light-house | 49 06 28 | 2 48 49 | | | | |
| | Cape Carteret: Light-house | 49 22 27 | 1 48 25 | 6 07 | 0 15 | 30.8 | 13.5 |
| | Coutances: Cathedral tower | 49 02 54 | 1 26 39 | | | | |
| | Granville: Light-house | 48 50 07 | 1 36 46 | 5 50 | 0 09 | 36.7 | 16.0 |
| | Chausey Is.: Light on SE. end of large id. | 48 52 13 | 1 49 20 | 5 55 | 0 04 | 34.7 | 15.2 |
| | St. Malo: Rochebourne light | 48 40 18 | 1 58 41 | 5 43 | 0 04 | 36.0 | 15.7 |
| | Cape Frehel: Light-house | 48 41 05 | 2 19 08 | | | | |
| | Heau de Brehat: Light-house | 48 54 33 | 3 05 11 | 5 35 | 12 00 | 30.4 | 13.3 |
| | Morlaix, Ile Noire: Light-house | 48 40 23 | 3 52 33 | 5 00 | 11 25 | 23.1 | 10.6 |
| | De Bas Islet: Light-house | 48 44 45 | 4 01 38 | 4 35 | 11 00 | 22.0 | 10.1 |
| | Abervrach: Light on Vrach Islet | 48 36 57 | 4 34 34 | 4 00 | 10 25 | 20.6 | 9.5 |
| | Ushant: Stiff Point light | 48 28 31 | 5 03 26 | 3 35 | 10 00 | 18.9 | 8.7 |
| | Brest: Observatory | 48 23 32 | 4 29 36 | 3 23 | 9 45 | 19.5 | 9.0 |
| | Brest (approach): Quelern light | 48 19 10 | 4 34 28 | | | | |
| | De Sein Islet: Light-house | 48 02 40 | 4 52 03 | 3 25 | 9 53 | 17.2 | 7.9 |
| | Bec du Raz: Light-house | 48 02 28 | 4 45 25 | | | | |
| | Audierne: Pier-head light | 48 00 47 | 4 32 50 | 3 04 | 9 31 | 11.1 | 5.1 |
| | Penmarch Rocks: Light-house | 47 47 52 | 4 22 30 | 3 05 | 9 34 | 13.3 | 6.1 |
| | Glenan Islands: Light, Penfret I | 47 43 17 | 3 57 15 | 3 00 | 9 27 | 13.0 | 6.0 |
| | De Groix Island: Light-house | 47 38 51 | 3 30 35 | | | | |
| | Lorient: Church-tower light | 47 44 53 | 3 21 31 | 3 09 | 9 36 | 13.8 | 6.3 |
| | Belle Isle: Light-house | 47 18 42 | 3 13 38 | 3 25 | 9 50 | 16.6 | 7.7 |
| | Port Haliguen: Light on N. jetty | 47 29 10 | 3 06 09 | 3 35 | 9 58 | 16.9 | 7.9 |
| | Haedic Island: Light-house | 47 19 18 | 2 50 07 | 3 20 | 9 46 | 16.7 | 7.7 |
| | Port Navalo: Light-house | 47 32 53 | 2 55 08 | 3 45 | 10 08 | 16.6 | 7.7 |
| | Vannes: St. Pierre Church | 47 39 30 | 2 45 28 | 5 47 | 12 11 | 15.8 | 7.4 |
| | Le Four Rock: Light-house | 47 17 53 | 2 38 05 | | | | |
| | Croisic: End of breakwater | 47 18 30 | 2 31 25 | 3 25 | 9 47 | 16.7 | 7.7 |
| | Guerande: Steeple | 47 19 44 | 2 25 48 | | | | |
| | Port St. Nazaire: Light-house | 47 16 18 | 2 11 50 | 3 35 | 9 56 | 16.6 | 7.7 |
| | Paimbœuf: Steeple | 47 17 17 | 2 02 09 | 4 18 | 10 39 | 17.0 | 7.9 |
| | Nantes: Cathedral | 47 13 08 | 1 32 59 | 5 50 | 12 28 | 16.5 | 7.7 |
| | Noir Moutier Island: Light-house | 47 00 41 | 2 13 16 | 3 05 | 9 26 | 16.7 | 7.7 |
| | Le Pilier Island: Light-house | 47 02 35 | 2 21 37 | | | | |
| | D'Yeu Island: Light-house | 46 43 04 | 2 22 56 | 3 18 | 9 40 | 14.7 | 6.8 |
| | La Chaume: Light-house | 46 29 38 | 1 47 45 | 3 20 | 9 44 | 12.7 | 5.9 |
| | Point de Grouin du Cou: Light-house | 46 20 41 | 1 27 49 | | | | |
| | Ré Island: Light, NW. pt | 46 14 40 | 1 33 40 | | | | |
| | Rochelle: E. Quay light | 46 09 25 | 1 08 57 | 3 27 | 9 22 | 16.6 | 7.7 |
| | Aix Island: Light-house | 46 00 36 | 1 10 40 | 3 27 | 9 22 | 16.6 | 7.7 |
| | Rochefort: Hospital | 45 56 37 | 0 57 50 | 3 45 | 9 55 | 16.7 | 7.7 |
| | Oleron Island: Light NW. pt | 46 02 49 | 1 24 37 | | | | |
| | Point de la Coubre: Light-house | 45 41 39 | 1 15 16 | | | | |
| | Point Cordouan: Light-house | 45 35 14 | 1 10 24 | 3 35 | 9 53 | 16.8 | 7.8 |
| | Point de Grave: Light-house | 45 34 10 | 1 04 27 | | | | |
| | Bordeaux: St. André | 44 50 19 | 0 34 42 | 6 30 | 0 12 | 15.3 | 7.1 |
| | Bayonne: Cathedral | 43 29 29 | 1 28 43 | | | | |
| | Biarritz: Light-house | 43 29 38 | 1 33 16 | | | | |
| | St. Jean de Luz: St. Barbe Point light | 43 23 58 | 1 39 53 | 3 07 | 9 14 | 12.3 | 5.8 |
| Spain and Portugal. | Fuenterrabia: Light on Cape Higuera | 43 23 30 | 1 47 30 | | | | |
| | Port Pasages: Light at entrance | 43 20 05 | 1 56 05 | | | | |
| | San Sebastian: Monte Igueldo light | 43 19 22 | 2 01 40 | 2 55 | 9 05 | 11.7 | 5.5 |
| | Bilbao: Light on Galea Castle | 43 22 36 | 3 04 06 | 2 50 | 9 03 | 12.7 | 5.9 |
| | Castro Urdiales: Santa Ana Castle light | 43 24 20 | 3 16 10 | 2 50 | 9 03 | 11.8 | 5.5 |
| | Santoña: Pescador Point light | 43 28 36 | 3 28 06 | 2 55 | 9 07 | 12.3 | 5.7 |
| | Santander: Cape Mayor light | 43 29 30 | 3 47 40 | 3 05 | 9 18 | 14.8 | 6.9 |
| | San Martin de la Arena: Light-house | 43 26 50 | 4 01 00 | 3 00 | 9 14 | 11.7 | 5.5 |
| | San Vincent de la Barquera: End of new mole | 43 23 35 | 4 24 55 | 3 00 | 9 14 | 10.4 | 4.9 |
| | Rivadesella: Mount Somos light | 43 31 00 | 5 07 10 | | | | |
| | Gijon: Santa Catalina light | 43 32 48 | 5 40 11 | 2 50 | 9 03 | 13.5 | 6.3 |
| | Aviles: Light-house | 43 38 05 | 5 56 00 | 2 45 | 8 58 | 12.0 | 4.9 |
| | Rivadeo: Light-house | 43 34 40 | 7 03 00 | 2 45 | 8 58 | 14.4 | 3.9 |
| | Estaca Point: Light-house | 43 47 20 | 7 42 00 | | | | |

### MARITIME POSITIONS AND TIDAL DATA.

#### ATLANTIC COAST OF EUROPE—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Spain and Portugal.** | Port Cedeira: Light-house | 43 39 00 | 8 05 30 | 2 43 | 8 56 | 14.8 | 6.1 |
| | Ferrol: Old naval observatory | 43 29 30 | 8 13 29 | 2 44 | 8 57 | 14.9 | 6.1 |
| | Priorino Chico light | 43 27 30 | 8 20 20 | | | | |
| | Coruña: Hercules Tower light | 43 23 10 | 8 24 26 | 2 43 | 8 56 | 14.8 | 6.1 |
| | Cape Finisterre: Light-house | 42 52 45 | 9 15 28 | 2 42 | 8 55 | 10.0 | 4.6 |
| | Vigo: Cres I. light | 42 12 30 | 8 54 00 | | | | |
| | Oporto: Light, N. S. de Luz | 41 09 10 | 8 40 35 | 2 25 | 8 38 | 10.0 | 4.3 |
| | Cape Mondego: Light-house | 40 10 47 | 8 54 15 | 2 20 | 8 35 | 7.0 | 3.0 |
| | Berlanga Island: Light-house | 39 24 49 | 9 30 29 | | | | |
| | Peniche: Light-house | 39 21 00 | 9 22 30 | 2 05 | 8 15 | 7.8 | 3.4 |
| | Cape Roca: Light-house | 38 46 49 | 9 29 46 | | | | |
| | Lisbon: Royal Observatory | 38 42 31 | 9 11 10 | 2 20 | 8 05 | 11.1 | 4.8 |
| | Setubal: Light-house | 38 29 15 | 8 56 00 | 2 10 | 8 20 | 11.6 | 5.0 |
| | Cape St. Vincent: Light-house | 37 01 20 | 8 58 00 | | | | |
| | Lagos: Church | 37 07 48 | 8 39 53 | 1 55 | 8 08 | 13.0 | 5.6 |
| | Cape Sta. Maria: Light-house | 36 58 23 | 7 51 48 | | | | |
| | Ayamonte: Light-house | 37 11 00 | 7 24 00 | | | | |
| | Huelva: Plaza at head of mole | 37 15 08 | 6 57 12 | | | | |
| | San Lucar: Chipiona light | 36 43 58 | 6 26 30 | 1 15 | 7 28 | 12.3 | 5.6 |
| | Cadiz: Observatory of San Fernando | 36 27 40 | 6 12 20 | | | | |
| | San Sebastian light | 36 31 30 | 6 19 00 | 1 45 | 7 58 | 11.8 | 5.4 |
| | Cape Trafalgar: Light-house | 36 10 50 | 6 02 08 | | | | |
| | Tarifa: Light-house | 35 59 53 | 5 36 31 | 1 32 | 7 52 | 5.6 | 2.6 |
| | Algeciras: Verde I. light | 36 07 19 | 5 26 12 | | | | |
| | Gibraltar: Dockyard flagstaff | 36 07 10 | 5 21 17 | | | | |
| | Europa Pt. light | 36 06 25 | 5 20 42 | 1 35 | 7 55 | 3.7 | 1.7 |

#### COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| **Spain.** | Malaga: Light-house | 36 42 39 | 4 24 38 | 2 15 | 8 35 | 2.9 | 1.5 |
| | Almeria: Light-house | 36 50 12 | 2 27 50 | | | | |
| | Cape de Gata: Light-house | 36 42 57 | 2 11 12 | | | | |
| | Mazarron: Light-house | 37 33 28 | 1 15 12 | | | | |
| | Cartagena: Arsenal gate | 37 35 50 | 0 59 09 | | | | |
| | Escombrera light | 37 33 22 | 0 57 58 | | | | |
| | Porman: Light-house | 37 34 38 | 0 50 20 | | | | |
| | Santa Pola Bay: Light-house | 38 12 30 | 0 30 12 | | | | |
| | Alicante: N. mole light | 38 20 12 | 0 28 48 | | | | |
| | Villajoyose: Light-house | 38 30 00 | 0 11 42 | | | | |
| | Benidonne: Tower | 38 30 57 | 0 10 06 | | | | |
| | Altea: Light-house | 38 33 30 | 0 04 02 | | | | |
| | | | Long. E. | | | | |
| | Calpe: Church tower | 38 38 36 | 0 02 52 | | | | |
| | Morayva: Tower | 38 40 51 | 0 09 17 | | | | |
| | Jarea: Cape San Antonio light | 38 48 06 | 0 12 02 | | | | |
| | Denia: Mole-head light | 38 51 00 | 0 07 30 | | | | |
| | | | Long. W. | | | | |
| | Cape Cullera: Light-house | 39 12 15 | 0 13 37 | | | | |
| | Valencia: Light-house | 39 28 05 | 0 19 48 | | | | |
| | Mole-end light | 39 27 50 | 0 18 50 | 5 00 | 11 30 | 1.5 | 0.8 |
| | | | Long. E. | | | | |
| | Columbretes Islands: Light-house | 39 53 57 | 0 41 19 | | | | |
| | Oropesa Cape: Light-house | 40 04 53 | 0 08 56 | | | | |
| | Vinaroz: Mole-head light | 40 27 48 | 0 28 48 | | | | |
| | Port Alfaques: Baña light | 40 33 30 | 0 39 45 | | | | |
| | Cape Tortosa: Light-house | 40 43 10 | 0 53 55 | | | | |
| | Tarragona: E. mole light | 41 06 00 | 1 14 42 | | | | |
| | Barcelona: E. mole-head light | 41 22 10 | 2 10 52 | | | | |
| | Palamos Bay: Molino Pt. light | 41 50 04 | 3 08 28 | | | | |
| | Cadaques: Clock tower | 42 16 15 | 3 17 10 | | | | |
| | Cape Creux: Light-house | 42 19 10 | 3 18 55 | | | | |
| **Fr.** | Cape Bear: Light-house | 42 30 59 | 3 07 30 | | | | |
| | Port Vendres: Fort Fanal light | 42 31 18 | 3 06 50 | | | | |

### MARITIME POSITIONS AND TIDAL DATA.

**COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.**

| Coast. | Place. | Lat. N. | Long E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| France. | Port Nouvelle: S. jetty light............ | 43 00 47 | 3 04 08 | ......... | ......... | ...... | ...... |
| | Cette: Light, St. Louis mole............ | 43 23 50 | 3 42 08 | ......... | ......... | ...... | ...... |
| | Aigues Mortes: Espignette Pt. light..... | 43 29 17 | 4 08 32 | ......... | ......... | ...... | ...... |
| | Planier Rock: Light-house............ | 43 11 57 | 5 13 51 | ......... | ......... | ...... | ...... |
| | Marseille: Janet Cliff light........... | 43 20 43 | 5 20 46 | 7 31 | 2 00 | 0.6 | 0.3 |
| | New observatory............... | 43 18 22 | 5 23 43 | ......... | ......... | ...... | ...... |
| | Ciotat: Berouard mole light............ | 43 10 21 | 5 36 42 | ......... | ......... | ...... | ...... |
| | Toulon: St. Mandrien light............ | 43 05 10 | 5 56 06 | 8 22 | 2 24 | 0.6 | 0.2 |
| | Grand Riband Island: Light-house...... | 43 01 01 | 6 08 39 | ......... | ......... | ...... | ...... |
| | Cannes: Light-house................ | 43 32 51 | 7 00 54 | ......... | ......... | ...... | ...... |
| | Antibes: Garoupe light ................ | 43 33 51 | 7 08 02 | ......... | ......... | ...... | ...... |
| | Nice: Light-house ................... | 43 41 32 | 7 17 13 | ......... | ......... | ...... | ...... |
| | Ville Franche: Mole-head light......... | 43 41 58 | 7 18 42 | ......... | ......... | ...... | ...... |
| | Cape Ferret light ...... | 43 40 30 | 7 19 41 | ......... | ......... | ...... | ...... |
| Bal. I. | Port Ibiza: Light-house................ | 38 54 10 | 1 27 25 | ......... | ......... | ...... | ...... |
| | Cabrera Island: Light-house.......... | 39 06 34 | 2 57 20 | ......... | ......... | ...... | ...... |
| | Pi (Majorca): Light-house ............ | 39 33 00 | 2 37 00 | ......... | ......... | ...... | ...... |
| | Port Mahon (Minorca): Light-house.... | 39 51 53 | 4 18 20 | ......... | ......... | ...... | ...... |
| Sardinia. | Cape Spartivento: Light-house ......... | 38 52 34 | 8 51 08 | ......... | ......... | ...... | ...... |
| | Cape Sandalo: Light on San Pietro I .... | 39 08 44 | 8 13 29 | ......... | ......... | ...... | ...... |
| | Porte Conte: Cape Caccia light ........ | 40 33 50 | 8 10 00 | ......... | ......... | ...... | ...... |
| | Port Torres: Light-house............. | 40 50 25 | 8 23 56 | ......... | ......... | ...... | ...... |
| | Cape Testa: Light-house .............. | 41 14 36 | 9 08 35 | ......... | ......... | ...... | ...... |
| | Razzoli Island: Light-house........... | 41 18 24 | 9 20 21 | ......... | ......... | ...... | ...... |
| | Caprera Island: Galera Pt............. | 41 14 15 | 9 29 40 | ......... | ......... | ...... | ...... |
| | Cape Figari: Signal station ........... | 40 59 52 | 9 39 07 | ......... | ......... | ...... | ...... |
| | Cape Tavolara: Light-house........... | 40 54 55 | 9 44 22 | ......... | ......... | ...... | ...... |
| | Cape Bellavista: Light-house.......... | 39 55 45 | 9 43 25 | ......... | ......... | ...... | ...... |
| | Cape Carbonera: Cavoli I. light ........ | 39 05 15 | 9 32 35 | ......... | ......... | ...... | ...... |
| | Cagliari: Light on mole................ | 39 12 35 | 9 07 20 | ......... | ......... | ...... | ...... |
| Corsica. | Bonifacio: Mount Pertusato light....... | 41 22 10 | 9 11 15 | ......... | ......... | ...... | ...... |
| | Ajaccio: Light-house................. | 41 52 50 | 8 35 45 | ......... | ......... | ...... | ...... |
| | Corti: Church tower.................. | 42 18 14 | 9 09 04 | ......... | ......... | ...... | ...... |
| | Calvi: Light-house ................... | 42 35 10 | 8 43 25 | ......... | ......... | ...... | ...... |
| | Cape Corso: Giraglia I. light.......... | 43 01 45 | 9 24 10 | ......... | ......... | ...... | ...... |
| | Bastia: Light-house.................. | 42 41 47 | 9 27 00 | ......... | ......... | ...... | ...... |
| | Porto Vecchio: Chiape Pt. light ........ | 41 35 45 | 9 22 05 | ......... | ......... | ...... | ...... |
| Italy. | Cape Melle: Light-house................ | 43 57 17 | 8 10 22 | ......... | ......... | ...... | ...... |
| | Genoa: San Benigno light.............. | 44 24 15 | 8 54 19 | ......... | ......... | ...... | ...... |
| | Spezzia: Fort Santa Maria light......... | 44 04 00 | 9 50 48 | ......... | ......... | ...... | ...... |
| | Florence: Observatory................. | 43 46 04 | 11 15 22 | ......... | ......... | ...... | ...... |
| | Leghorn (Livorno): Light on S. end of curved breakwater.................... | 43 32 33 | 10 17 25 | ......... | ......... | ...... | ...... |
| | Capraia Island: Cape Ferrajone light.... | 43 02 57 | 9 51 07 | ......... | ......... | ...... | ...... |
| | Elba Island, Porto Longone: Fort For-cado light............................. | 42 45 14 | 10 24 38 | ......... | ......... | ...... | ...... |
| | Pianosa Island: Light on battery, W. side of fort ......................... | 42 35 06 | 10 05 50 | ......... | ......... | ...... | ...... |
| | Africa Rock: Light-house ............. | 42 21 28 | 10 03 54 | ......... | ......... | ...... | ...... |
| | Monte Christo Islet: Summit.......... | 42 20 15 | 10 18 39 | ......... | ......... | ...... | ...... |
| | Giglio Island, Cape Rosso: Light-house . | 42 19 13 | 10 55 24 | ......... | ......... | ...... | ...... |
| | Civita Vecchia: Light N. end of break-water.............................. | 42 05 38 | 11 46 50 | ......... | ......... | ...... | ...... |
| | Rome: Observatory.................... | 41 53 54 | 12 28 40 | ......... | ......... | ...... | ...... |
| | Gaeta: Orlando tower................. | 41 12 27 | 13 35 15 | ......... | ......... | ...... | ...... |
| | Ponza Islet: Punto della Guardia light .. | 40 52 38 | 12 57 17 | ......... | ......... | ...... | ...... |
| | Naples: Observatory.................. | 40 51 46 | 14 14 44 | ......... | ......... | ...... | ...... |
| | Light on elbow of mole.......... | 40 50 15 | 14 15 38 | 4 00 | 10 13 | 0.7 | 0.2 |
| | Capri Island: Carena Pt. light......... | 40 32 07 | 14 11 40 | ......... | ......... | ...... | ...... |
| | Lipari Island: Casa Bianca light........ | 38 28 43 | 14 51 40 | ......... | ......... | ...... | ...... |
| | Ustica Island: NE. point light.......... | 38 42 40 | 13 12 00 | ......... | ......... | ...... | ...... |
| | Faro di Messina: Capo di Faro light .... | 38 16 02 | 15 39 11 | ......... | ......... | ...... | ...... |
| | Milazzo: Light-house................. | 38 16 10 | 15 13 42 | ......... | ......... | ...... | ...... |
| | Palermo: Observatory ................ | 38 06 44 | 13 21 16 | ......... | ......... | ...... | ...... |
| | Light on mole head .......... | 38 07 56 | 13 22 04 | ......... | ......... | ...... | ...... |
| | Trapani: Palumbo Rock light .......... | 38 00 39 | 12 29 50 | ......... | ......... | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

**COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Italy. | Maritimo Island: Light on SW. pt...... | 37 57 13 | 12 02 55 | ...... | ...... | ...... | ...... |
| | Marsala: W. mole light ............... | 37 47 10 | 12 25 59 | ...... | ...... | ...... | ...... |
| | Girgenti: Port Empedoche light......... | 37 16 55 | 13 32 27 | ...... | ...... | ...... | ...... |
| | Gozo Island: Light on NW. pt ......... | 36 04 10 | 14 12 55 | ...... | ...... | ...... | ...... |
| | Malta Island, Valetta Harbor: Light-house...... | 35 54 00 | 14 31 30 | 3 12 | 9 25 | 0.7 | 0.2 |
| | Linosa Island: Landing Cove........... | 35 51 50 | 12 52 09 | ...... | ...... | ...... | ...... |
| | Lampedusa Island: Carallo Bianco light. | 35 29 37 | 12 36 12 | ...... | ...... | ...... | ...... |
| | Cape Passaro: Light-house ............. | 36 41 03 | 15 07 45 | ...... | ...... | ...... | ...... |
| | Syracuse: Maniace Castle light ......... | 37 03 04 | 15 17 37 | ...... | ...... | ...... | ...... |
| | Augusta Port: Torre d'Avola light ...... | 37 12 39 | 15 13 20 | 3 00 | 9 13 | 0.9 | 0.3 |
| | Catania: Sciari Biscari light ........... | 37 29 35 | 15 05 19 | ...... | ...... | ...... | ...... |
| | Cape Taormina: Semaphore............. | 37 50 25 | 15 18 30 | ...... | ...... | ...... | ...... |
| | Messina: San Ranieri light............. | 38 11 33 | 15 34 36 | ...... | ...... | ...... | ...... |
| | Cape Peloro: Light-house ............. | 38 16 02 | 15 39 11 | ...... | ...... | ...... | ...... |
| | Cape Spartivento: Light-house ......... | 37 55 29 | 16 03 31 | ...... | ...... | ...... | ...... |
| | Cape Colonna: Light-house ............ | 39 01 29 | 17 12 09 | ...... | ...... | ...... | ...... |
| | Cotrone: Mole-head light ............. | 39 04 38 | 17 08 07 | ...... | ...... | ...... | ...... |
| | Taranto: Cape St. Vito light........... | 40 24 41 | 17 12 23 | ...... | ...... | ...... | ...... |
| | Gallipoli: St. Andrea light ............ | 40 02 48 | 17 56 55 | ...... | ...... | ...... | ...... |
| | Cape Sta. Maria di Leuca: Light-house.. | 39 47 43 | 18 22 17 | ...... | ...... | ...... | ...... |
| | Cape Otranto: Light-house............. | 40 06 23 | 18 31 25 | ...... | ...... | ...... | ...... |
| | Port Otranto: Castle .................. | 40 09 06 | 18 28 45 | ...... | ...... | ...... | ...... |
| | Brindisi: Light-house................. | 40 39 36 | 17 59 37 | 3 30 | 9 43 | 1.8 | 0.5 |
| | Bari: St. Catalolo light............... | 41 08 19 | 16 50 52 | ...... | ...... | ...... | ...... |
| | Viesti: Light on St. Croce Rock ........ | 41 53 17 | 16 11 13 | ...... | ...... | ...... | ...... |
| | Manfredonia: Light-house ............. | 41 37 39 | 15 55 34 | ...... | ...... | ...... | ...... |
| | Tremiti Islands: Caprara I. light........ | 42 08 14 | 15 31 36 | ...... | ...... | ...... | ...... |
| | Ancona: Monte Cappucini light ........ | 43 37 14 | 13 31 18 | ...... | ...... | ...... | ...... |
| | Malamocco: Rocchetta Mole light ...... | 45 20 30 | 12 19 09 | 10 15 | 4 45 | 3.3 | 0.9 |
| | Venice: Site of tower of St. Mark....... | 45 25 58 | 12 20 29 | ...... | ...... | ...... | ...... |
| Austria. | Grado: Church tower.................... | 45 41 06 | 13 22 54 | ...... | ...... | ...... | ...... |
| | Monfalcone: Church tower............. | 45 48 33 | 13 32 10 | ...... | ...... | ...... | ...... |
| | Trieste: Observatory Nautical Academy. | 45 38 51 | 13 46 00 | ...... | ...... | ...... | ...... |
| | Theresa Mole light ............. | 45 38 54 | 13 45 14 | 9 20 | 3 50 | 2.0 | 0.6 |
| | Capo d'Istria: Light-house ............. | 45 33 00 | 13 43 18 | ...... | ...... | ...... | ...... |
| | Isola: Light-house.................... | 45 32 34 | 13 39 32 | ...... | ...... | ...... | ...... |
| | Pirano: Light-house .................. | 45 31 54 | 13 33 48 | ...... | ...... | ...... | ...... |
| | Salvore Point: Light-house............. | 45 29 24 | 13 29 30 | ...... | ...... | ...... | ...... |
| | Citta Nuova: Light-house ............. | 45 19 16 | 13 33 42 | ...... | ...... | ...... | ...... |
| | Parenzo: Cathedral tower ............. | 45 13 45 | 13 35 39 | ...... | ...... | ...... | ...... |
| | Rovigno: St. Eufemia light............. | 45 05 00 | 13 38 00 | ...... | ...... | ...... | ...... |
| | Pola: N. cupola of observatory ......... | 44 51 49 | 13 50 46 | 9 00 | 3 25 | 3.4 | 0.9 |
| | Promontore Point: Porer Rock light..... | 44 45 30 | 13 53 36 | ...... | ...... | ...... | ...... |
| | Nera Point: Light-house .............. | 44 57 24 | 14 08 42 | ...... | ...... | ...... | ...... |
| | Fiume: Cathedral tower ............... | 45 19 36 | 14 26 41 | 8 15 | 2 35 | 1.2 | 0.3 |
| | Porto Ré: Light-house................. | 45 16 18 | 14 33 42 | ...... | ...... | ...... | ...... |
| | Veglia: Mole head.................... | 45 01 30 | 14 34 36 | ...... | ...... | ...... | ...... |
| | Prestenizza Point: Light-house ........ | 45 07 12 | 14 16 30 | ...... | ...... | ...... | ...... |
| | Cherso: Kimen Point light............. | 44 57 36 | 14 23 30 | ...... | ...... | ...... | ...... |
| | Galiola Rock: Light-house ............. | 44 43 36 | 14 10 36 | ...... | ...... | ...... | ...... |
| | Unie Island: Netak Point light........ | 44 37 20 | 14 14 06 | ...... | ...... | ...... | ...... |
| | Lussin Piccolo: Sta. Maria Church...... | 44 31 49 | 14 28 06 | 8 10 | 2 25 | 1.1 | 0.3 |
| | St. Pietro di Nembo Island: Health office. | 44 27 42 | 14 33 28 | ...... | ...... | ...... | ...... |
| | Gruizza Rock: Light-house............. | 44 24 42 | 14 34 06 | ...... | ...... | ...... | ...... |
| | Zengg: Mole-head light............... | 44 59 24 | 14 53 48 | ...... | ...... | ...... | ...... |
| | Terstenik Rock: Light-house .......... | 44 40 06 | 14 34 42 | ...... | ...... | ...... | ...... |
| | Carlobago: Light-house ............... | 44 31 30 | 15 04 24 | ...... | ...... | ...... | ...... |
| | Zara: Church tower ................... | 44 07 05 | 15 14 05 | ...... | ...... | ...... | ...... |
| | Bianche Point: Light-house ........... | 44 09 06 | 14 49 24 | ...... | ...... | ...... | ...... |
| | Zara Vecchia: Church tower ........... | 43 56 16 | 15 26 21 | ...... | ...... | ...... | ...... |
| | Port Tajer: Lestrice I. light ........... | 43 51 15 | 15 12 06 | ...... | ...... | ...... | ...... |
| | Lucrietta Island: Light-house .......... | 43 37 36 | 15 34 24 | ...... | ...... | ...... | ...... |
| | Sebenico: Mount Tartaro.............. | 43 45 08 | 15 58 07 | 6 10 | 0 20 | 1.0 | 0.3 |
| | Rogosnizza Port: Mulo Rock light...... | 43 31 00 | 15 55 00 | ...... | ...... | ...... | ...... |
| | Zirona Grande Island: St. George Church tower ................... | 43 27 00 | 16 08 51 | ...... | ...... | ...... | ...... |
| | Trani: Cathedral tower ............... | 43 31 02 | 16 15 09 | ...... | ...... | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

**COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Austria. | Port Spalato: Cathedral tower.......... | 43 30 07 | 16 26 06 | ........ | ........ | ...... | ...... |
| | Solta I., Port Olivetto: St. Nicholas tower.. | 43 23 50 | 16 11 10 | ........ | ........ | ...... | ...... |
| | Spalato Passage: Speo Pt. light ......... | 43 19 12 | 16 24 30 | ........ | ........ | ...... | ...... |
| | Makarska: Church tower ............... | 43 17 46 | 17 01 36 | ........ | ........ | ...... | ...... |
| | Pomo Rock: Center .................... | 43 05 28 | 15 27 30 | ........ | ........ | ...... | ...... |
| | St. Andrea Rock: Summit.............. | 43 01 43 | 15 45 29 | ........ | ........ | ...... | ...... |
| | Lissa Island: Hoste Rock light ......... | 43 04 30 | 16 12 28 | 4 00 | 10 30 | 2.4 | 0.7 |
| | Pakonjidol Rock: Light-house.......... | 43 09 24 | 16 27 14 | ........ | ........ | ...... | ...... |
| | Lesina Island: Port Gelsa light ...... | 43 09 50 | 16 41 55 | ........ | ........ | ...... | ...... |
| | St. Giorgio Pt. light ...... | 43 07 30 | 17 12 00 | ........ | ........ | ...... | ...... |
| | Sabioncello Peninsula: Cape Gomena light...................... | 43 02 50 | 17 00 19 | ........ | ........ | ...... | ...... |
| | Sorelle Rocks: Light-house............. | 42 57 42 | 17 12 44 | ........ | ........ | ...... | ...... |
| | Curzola Island: Porto Bema mole head.. | 42 54 19 | 16 51 32 | ........ | ........ | ...... | ...... |
| | Porto Valle Grande, church tower ........ | 42 57 37 | 16 43 07 | ........ | ........ | ...... | ...... |
| | Lagostini Island: Glavat Rock light..... | 42 45 54 | 17 08 54 | ........ | ........ | ...... | ...... |
| | Lagosta Island: St. George Chapel...... | 42 45 05 | 16 51 45 | ........ | ........ | ...... | ...... |
| | Cazza Island: Light-house.............. | 42 45 05 | 16 29 29 | ........ | ........ | ...... | ...... |
| | Pelagosa Rock: Light-house............ | 42 23 30 | 16 15 12 | ........ | ........ | ...... | ...... |
| | Meleda Island: Port Palazzo Ruin ...... | 42 47 06 | 17 22 51 | ........ | ........ | ...... | ...... |
| | Olipa Rock: Light-house............... | 42 45 30 | 17 46 48 | ........ | ........ | ...... | ...... |
| | Pettini di Ragusa Rocks: Light-house... | 42 39 00 | 18 03 08 | ........ | ........ | ...... | ...... |
| | Bobara Rock: Summit ................. | 42 35 08 | 18 10 49 | ........ | ........ | ...... | ...... |
| | Molonta Peninsula: Summit............ | 42 27 04 | 18 25 36 | ........ | ........ | ...... | ...... |
| | Ostro Point: Light-house.............. | 42 23 36 | 18 32 00 | ........ | ........ | ...... | ...... |
| | Cattaro: Health office................. | 42 25 30 | 18 46 12 | ........ | ........ | ...... | ...... |
| | Budua: Mole-head light .............. | 42 16 42 | 18 50 36 | ........ | ........ | ...... | ...... |
| | Katic Rock: St. Domenica Chapel ...... | 42 11 43 | 18 56 25 | ........ | ........ | ...... | ...... |
| | Antivari: Pt. Valovica light ........... | 42 05 15 | 19 04 19 | ........ | ........ | ...... | ...... |
| | Dulcigno: W. windmill ................ | 41 55 47 | 19 12 29 | ........ | ........ | ...... | ...... |
| Turkey. | Cape Rodoni: Guard-house............. | 41 35 10 | 19 27 15 | ........ | ........ | ...... | ...... |
| | Cape Pali: Guard-house................ | 41 23 31 | 19 24 54 | ........ | ........ | ...... | ...... |
| | Durazzo: Light-house ................. | 41 18 40 | 19 27 14 | ........ | ........ | ...... | ...... |
| | Cape Laghi: Ruin..................... | 41 08 44 | 19 26 47 | ........ | ........ | ...... | ...... |
| | Skumbi River: Pyramid at mouth....... | 41 02 12 | 19 26 30 | ........ | ........ | ...... | ...... |
| | Semeny River: Samana Pt. light........ | 40 47 00 | 19 20 14 | ........ | ........ | ...... | ...... |
| | Vojazza River: Pyramid at mouth ...... | 40 36 14 | 19 19 14 | ........ | ........ | ...... | ...... |
| | Saseno Island: Light-house............. | 40 30 12 | 19 16 15 | ........ | ........ | ...... | ...... |
| | Avlona: Light-house .................. | 40 25 30 | 19 27 55 | ........ | ........ | ...... | ...... |
| | Cape Linguelta: Extreme............... | 40 25 17 | 19 17 45 | ........ | ........ | ...... | ...... |
| | Mount Cica: Pyramid.................. | 40 12 00 | 19 38 33 | ........ | ........ | ...... | ...... |
| | Port Palermo: Pyramid ............... | 40 02 57 | 19 47 53 | ........ | ........ | ...... | ...... |
| | Cape Kiefali: Pyramid ................ | 39 54 29 | 19 54 55 | ........ | ........ | ...... | ...... |
| | Fano Island: Pt. Kastri light ......... | 39 51 53 | 19 26 06 | ........ | ........ | ...... | ...... |
| | Port Pagonia: Ruin ................... | 39 39 27 | 20 07 12 | ........ | ........ | ...... | ...... |
| | Port Gomenitza: Well Dogana.......... | 39 29 50 | 20 17 09 | ........ | ........ | ...... | ...... |
| | Port Parga: Madonna I ................ | 39 16 32 | 20 24 55 | ........ | ........ | ...... | ...... |
| Greece. | Port St. Spiridione: Convent ........... | 39 39 54 | 19 43 09 | ........ | ........ | ...... | ...... |
| | Corfu: Light-house ................... | 39 37 05 | 19 56 30 | ........ | ........ | ...... | ...... |
| | Paxo Island: Madonna I. light.......... | 39 11 30 | 20 12 34 | ........ | ........ | ...... | ...... |
| | Prevesa: Fort Nuovo minaret........... | 38 56 30 | 20 45 40 | ........ | ........ | ...... | ...... |
| | Port Drepano: Observation island ...... | 38 47 25 | 20 44 16 | ........ | ........ | ...... | ...... |
| | Port Vliko: Custom-house............. | 38 40 40 | 20 42 44 | ........ | ........ | ...... | ...... |
| | Port Vathi: Lazaretto light............ | 38 22 04 | 20 43 37 | ........ | ........ | ...... | ...... |
| | Port Argostoli: St. Theodoro light ...... | 38 11 36 | 20 29 30 | ........ | ........ | ...... | ...... |
| | Patras: Light-house................... | 38 15 00 | 21 43 50 | 3 40 | 9 53 | 1.0 | 0.3 |
| | Katakolo: Light-house................. | 37 38 20 | 21 18 55 | ........ | ........ | ...... | ...... |
| | Zante: Mole light..................... | 37 47 10 | 20 55 26 | ........ | ........ | ...... | ...... |
| | Strovathi, or Strivali Island: Stamphani I. light........./................. | 37 15 12 | 21 01 14 | ........ | ........ | ...... | ...... |
| | Proti Passage: Marathon Pt ........... | 37 03 38 | 21 34 35 | ........ | ........ | ...... | ...... |
| | Navarin: Light-house.................. | 36 54 10 | 21 40 29 | ........ | ........ | ...... | ...... |
| | Mothoni: Round tower ................ | 36 48 40 | 21 42 40 | ........ | ........ | ...... | ...... |
| | Koroni Anchorage: Mole light......... | 36 47 50 | 21 58 00 | ........ | ........ | ...... | ...... |
| | Petalidi Bay: Petalidi Pt............. | 36 57 20 | 21 56 42 | ........ | ........ | ...... | ---- |
| | Candia Island, Port Suda: Light-house.. | 35 28 55 | 24 09 39 | ........ | ........ | ...... | ...... |
| | Megalo Kastron: Mole light ................. | 35 20 30 | 25 09 44 | ........ | ........ | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

## COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Greece. | Kandeliusa Island: Light-house | 36 29 40 | 26 59 25 | | | | |
| | Stampali Island, Maltezana Port: Agios Ioanes | 36 34 25 | 26 24 28 | | | | |
| | Christiana Islands: N. pt | 36 15 20 | 25 13 00 | | | | |
| | Milo Island: Summit, Mt. St. Elias | 36 40 27 | 24 23 15 | | | | |
| | Siphano Island: Light-house | 36 59 12 | 24 40 30 | | | | |
| | Naxos Island, Naxia: Gate on Bacchus I. | 37 06 32 | 25 23 00 | | | | |
| | Paros Island, Port Trio: Trio Pt | 37 00 01 | 25 14 21 | | | | |
| | Port Naussa: St. Yanni Church | 37 08 38 | 25 14 08 | | | | |
| | Syra: Mole light | 37 26 12 | 24 56 14 | | | | |
| | Sermo Island: Amyno Pt | 37 07 36 | 24 32 23 | | | | |
| | Thermia Island: Ruins of Cythnus | 37 25 55 | 24 23 35 | | | | |
| | Jura Island: North pt | 37 38 00 | 24 44 32 | | | | |
| | Port St. Nikolo: Light-house | 37 39 28 | 24 19 44 | | | | |
| | St. Nikalao Island: Port Mandri | 37 44 00 | 24 04 12 | | | | |
| | Andros Island, Cape Fasse: Light-house | 37 57 30 | 24 42 30 | | | | |
| | Ieraka: Acropolis | 36 47 05 | 23 05 40 | | | | |
| | Port Kheli: Light-house | 37 18 42 | 23 08 53 | | | | |
| | Poros Island: Light-house | 37 31 45 | 23 25 45 | | | | |
| | Ægina: Light-house | 37 44 30 | 23 25 30 | | | | |
| | Piræus: Light-house | 37 56 14 | 23 38 10 | | | | |
| | Athens: Observatory | 37 58 20 | 23 43 55 | | | | |
| | Cape Colonna: Extreme | 37 38 45 | 24 02 15 | | | | |
| | Port Raphti: Statue I | 37 52 48 | 24 03 00 | | | | |
| | Petali Island: Trago I. peak | 38 01 28 | 24 16 42 | | | | |
| | Euripo Strait: Light-house | 38 28 15 | 23 36 45 | | | | |
| | Skiathos Island: Mount Stavros | 39 10 48 | 23 27 07 | | | | |
| | Salonika: S. bastion | 40 37 28 | 22 58 00 | | | | |
| | Port Baklar: Cape Xeros | 40 32 40 | 26 45 00 | | | | |
| | Lemnos Island: Kastro Castle | 39 52 10 | 25 03 20 | | | | |
| | Port Moudros: Sangrada Pt | 39 50 52 | 25 14 14 | | | | |
| | Strati Island: St. Strati Church | 39 31 58 | 24 59 13 | | | | |
| | Mityleni Island, Port Sigri: Light-house | 39 12 35 | 25 50 00 | | | | |
| | Mityleni: Light on Mityleni Pt | 39 06 10 | 26 34 54 | | | | |
| | Port Iero: Sidero Islet | 39 03 20 | 26 31 39 | | | | |
| | Psara Island: Fort | 38 32 00 | 25 35 00 | | | | |
| | Tchesmé: C. Kézil light | 38 19 55 | 26 17 45 | | | | |
| | Samos Island: Fonia Pt. light | 37 41 24 | 26 58 42 | | | | |
| | Port Iseue: Tower | 37 16 33 | 27 36 55 | | | | |
| | Kos: Light-house | 36 55 00 | 27 18 25 | | | | |
| | Marmorice Harbor: Adassi Pt. light | 36 48 00 | 28 18 00 | | | | |
| | Makry Harbor: Kasil I | 36 39 33 | 29 06 13 | | | | |
| | Rhodes Port: Arab's Tower light | 36 26 00 | 28 16 24 | | | | |
| | Port Lindo: Tower | 36 05 53 | 28 08 10 | | | | |
| Turkey. | Dardanelles: Hellas Pt. light | 40 02 30 | 26 10 54 | | | | |
| | Gallipoli: Light-house | 40 24 27 | 26 41 24 | | | | |
| | Bosphorus: Tofana Pt. light | 41 01 20 | 29 01 00 | | | | |
| | Scutari: Leander Tower light | 41 01 02 | 29 00 29 | | | | |
| | Constantinople: Seraglio Pt. light | 41 00 35 | 29 01 14 | | | | |
| | St. Sophia Mosque | 41 00 16 | 28 58 59 | | | | |
| | Cape Kara Burnu: Light-house | 41 21 15 | 28 42 14 | | | | |
| Russia. | Yuiada Road: Fort Tersana | 41 52 04 | 27 58 45 | | | | |
| | Burghaz: Light-house | 42 27 52 | 27 35 54 | | | | |
| | Varna Bay: Light-house | 43 10 00 | 27 58 35 | | | | |
| | Kusterjeh: Cape Kusterjeh light | 44 10 20 | 28 39 14 | | | | |
| | Danube River: Salina light | 45 09 47 | 29 41 14 | | | | |
| | Fidonisi Island: Light-house | 45 16 00 | 30 14 14 | | | | |
| | Odessa: Observatory | 46 28 36 | 30 45 34 | | | | |
| | Dnieper Bay: Fort Nikolaeo light | 46 34 27 | 31 33 36 | | | | |
| | Sebastopol: E. light-house | 44 36 55 | 33 36 26 | | | | |
| | Balaklava Bay: Hospital | 44 29 50 | 33 36 25 | | | | |
| | Kertch: Light-house | 45 21 03 | 36 28 30 | | | | |
| | Berdiansk: Breakwater light | 46 45 00 | 36 46 40 | | | | |
| | Saukhoum: Light-house | 42 58 00 | 40 55 10 | | | | |
| | Batoum: Light-house | 41 39 30 | 41 38 15 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### COASTS OF THE MEDITERRANEAN, ADRIATIC, AND BLACK SEAS—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Turkey.** | Trebizond: Light-house | 41 01 00 | 39 46 25 | | | | |
| | Sinope: Light-house | 42 01 20 | 35 13 20 | | | | |
| | Bender Erekli: Light-house | 41 18 03 | 31 25 49 | | | | |
| | Marmora Island: Light off E. pt. | 40 38 10 | 27 46 09 | | | | |
| | Artaki Bay: Zeitijn Adasi Islet | 40 23 30 | 27 47 30 | | | | |
| | Tenedos Island: Ponente Pt. light | 39 50 00 | 25 58 34 | | | | |
| | Port Ajano: Nikolo Rock | 39 01 21 | 26 47 57 | | | | |
| | Port Ali-Agha: W. pt. of entrance | 38 50 10 | 26 57 20 | | | | |
| | Smyrna: English consulate flag-staff | 38 25 40 | 27 09 10 | 9 15 | 3 15 | 2.5 | 0.7 |
| | Vourlah: Custom-house | 38 21 48 | 26 47 00 | | | | |
| | Sighajik Harbor: Beacon on islet | 38 12 21 | 26 47 32 | | | | |
| | Budrum: Light-house | 37 02 00 | 27 27 05 | | | | |
| | Adalia: Light-house | 36 52 00 | 30 45 34 | | | | |
| | Alexandretta: Light-house | 36 35 30 | 36 10 20 | | | | |
| | Latakiyah: Light-house | 35 30 30 | 35 46 30 | | | | |
| | Tripoli Roadstead: Bluff Islet light | 34 29 25 | 35 44 24 | | | | |
| | Ruad Island: Light-house | 34 52 00 | 35 51 00 | | | | |
| | Beirut: Light-house | 33 54 10 | 35 28 25 | 9 45 | 3 35 | 1.2 | 0.3 |
| | Saida (ancient Sidon): Light-house | 33 34 20 | 35 21 30 | | | | |
| | Sûr (ancient Tyre): Light-house | 33 16 30 | 35 14 40 | | | | |
| | Acre: Light-house | 32 54 35 | 35 08 00 | | | | |
| | Haifa: Light-house | 32 47 40 | 35 05 00 | | | | |
| **Cyprus.** | Famagusta: Light-house | 35 07 10 | 33 57 22 | 9 40 | 3 30 | 1.4 | 0.4 |
| | C. Gata: Light | 34 33 45 | 33 01 30 | | | | |
| | Lamaka: Light-house | 34 54 00 | 33 38 59 | | | | |
| **Egypt.** | Port Said: High light-house | 31 15 41 | 32 18 45 | 9 40 | 3 30 | 1.0 | 0.3 |
| | River Nile: Damietta Mouth | 31 31 40 | 31 51 00 | | | | |
| | Rosetta Mouth light | 31 29 30 | 30 19 10 | | | | |
| | Aboukir Bay: Nelson I. peak | 31 21 23 | 30 06 00 | | | | |
| | Alexandria: Eunostos Pt. light | 31 11 43 | 29 51 40 | 9 45 | 3 15 | 1.1 | 0.3 |
| | Ben Ghazi: Castle | 32 06 51 | 20 02 40 | 9 55 | 3 45 | 1.2 | 0.3 |
| | Tripoli Harbor: Light-house | 32 54 03 | 13 10 50 | 10 00 | 3 50 | 1.9 | 0.5 |
| **Tunis.** | Sfax: Ras Tina light | 34 39 01 | 10 41 17 | 3 35 | 9 57 | 4.2 | 1.1 |
| | Mehediah: Sidi Jubber | 35 30 24 | 11 05 15 | | | | |
| | Monastir: Burj el Kelb battery | 35 45 24 | 10 50 42 | | | | |
| | Hammamet Bay: Castle flag-staff | 36 23 20 | 10 37 10 | | | | |
| | Kalibia Road: Light-house | 36 50 12 | 11 07 00 | | | | |
| | Cape Bon: Light-house | 37 04 45 | 11 03 15 | | | | |
| | Tunis: Goletta light | 36 48 19 | 10 18 31 | 3 33 | 9 55 | 3.0 | 0.8 |
| **Algeria.** | Cape Farina: Extreme | 37 10 42 | 10 17 30 | | | | |
| | Benzert: N. Jetty light | 37 16 38 | 9 53 21 | | | | |
| | Galita Island: Monte Guardia | 37 31 16 | 8 56 12 | | | | |
| | Bona: Fort Genois light | 36 57 15 | 7 46 40 | | | | |
| | Stora: Singe I. light | 36 54 29 | 6 53 11 | | | | |
| | Cape Bougaroni: Light-house | 37 05 17 | 6 28 37 | | | | |
| | Cape Carbon: Light-house | 36 46 41 | 5 06 22 | | | | |
| | Algier: Light-house near Admiralty | 36 47 16 | 3 04 13 | 2 46 | 8 58 | 2.6 | 1.3 |
| | Cape Tenez: Light-house | 36 33 07 | 1 20 36 | | | | |
| | | | Long. W. | | | | |
| | Oran: Mers el Kebir light | 35 44 21 | 0 41 38 | | | | |
| | Habibas Island: Light-house | 35 43 22 | 1 07 57 | | | | |
| **Morocco.** | Zafarin Islands: Light Isabel Segunda I. | 35 11 05 | 2 25 45 | | | | |
| | Alboran Island: Light-house | 35 58 00 | 3 03 29 | | | | |
| | Ceuta: Light-house | 35 53 44 | 5 16 46 | 1 55 | 8 07 | 3.3 | 1.5 |
| | Tangier: Casbah tower | 35 47 00 | 5 48 31 | 1 30 | 7 40 | 8.0 | 3.7 |
| | Cape Spartel: Light-house | 35 47 14 | 5 55 41 | | | | |

### WEST COAST OF AFRICA.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | El Araish: S. pt. of entrance | 35 12 50 | 6 09 13 | | | | |
| | Sali: Fort | 34 04 10 | 6 48 00 | 1 35 | 7 45 | 10.4 | 4.8 |
| | Cape Dar el Beida: Light-house | 33 36 00 | 7 33 00 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

**WEST COAST OF AFRICA—Continued.**

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. H.W. | Lun. Int. L.W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Cape Blanco, North: Extreme.......... | 33 08 00 | 8 35 05 | ...... | ...... | ...... | ...... |
| | Mogador Harbor: English consulate..... | 31 30 30 | 9 43 30 | 1 05 | 7 17 | 10.9 | 5.0 |
| | Cape Ghir: Extreme................... | 30 38 00 | 9 50 00 | ...... | ...... | ...... | ...... |
| | Cape Noun: Extreme.................. | 28 45 00 | 11 02 00 | ...... | ...... | ...... | ...... |
| | Cape Juby: Extreme ................. | 27 56 00 | 12 56 00 | 11 55 | 5 43 | 8.5 | 3.9 |
| | Cape Bojador: Extreme............... | 26 07 57 | 14 29 00 | 11 50 | 5 38 | 7.3 | 3.4 |
| | Penha Grande........................ | 25 07 06 | 14 50 44 | ...... | ...... | ...... | ...... |
| | Ouro River entrance: Dumford Pt ...... | 23 36 03 | 15 58 00 | ...... | ...... | ...... | ...... |
| | Pedra de Galha...................... | 22 12 37 | 16 48 11 | ...... | ...... | ...... | ...... |
| | Cape Blanco, South: Extreme .......... | 20 46 27 | 17 05 40 | 11 35 | 5 23 | 5.5 | 2.5 |
| | Portendik: Village................... | 18 18 45 | 16 02 00 | ...... | ...... | ...... | ...... |
| | St. Louis: Light-house ............... | 16 01 31 | 16 30 22 | ...... | ...... | ...... | ...... |
| | Almadie Point: Light-house........... | 14 44 45 | 17 32 25 | ...... | ...... | ...... | ...... |
| | Cape Verde: Light-house.............. | 14 43 20 | 17 30 55 | ...... | ...... | ...... | ...... |
| | Port Dakar: Light-house ............. | 14 40 30 | 17 25 28 | ...... | ...... | ...... | ...... |
| | Cape Manoel: Light-house ............ | 14 38 55 | 17 26 47 | ...... | ...... | ...... | ...... |
| | Goree Island: Fort .................. | 14 39 55 | 17 24 30 | ...... | ...... | ...... | ...... |
| | Bird Island: Flagstaff ............... | 13 39 45 | 16 40 30 | ...... | ...... | ...... | ...... |
| | Bathurst: Flagstaff ................. | 13 28 00 | 16 35 00 | 9 00 | 2 50 | 5.9 | 2.7 |
| | Carabane: Light-house ............... | 12 35 00 | 16 44 00 | ...... | ...... | ...... | ...... |
| | Nunez River: Sand I ................. | 10 36 37 | 14 42 00 | ...... | ...... | ...... | ...... |
| | Ponga River entrance: Observation pt .. | 10 03 15 | 14 04 30 | 7 30 | 1 20 | 11.4 | 5.2 |
| | Isles de Los: Light-house ............. | 9 30 30 | 13 44 00 | ...... | ...... | ...... | ...... |
| | Matacong Island: House.............. | 9 16 10 | 13 26 20 | ...... | ...... | ...... | ...... |
| | Scarcies River: W. end of Yellaboi I.... | 8 57 05 | 13 18 25 | ...... | ...... | ...... | ...... |
| | Sierra Leone: Light on cape........... | 8 30 00 | 13 18 30 | 7 40 | 1 30 | 11.6 | 5.3 |
| | N. battery ............... | 8 29 57 | 13 14 30 | ...... | ...... | ...... | ...... |
| | Sherbro Island: N. island ............ | 7 40 36 | 13 04 30 | ...... | ...... | ...... | ...... |
| | Sherbro River: Manna Pt ............ | 7 22 45 | 12 31 55 | 5 50 | 12 00 | 10.4 | 4.8 |
| | Gallinas River: W. elbow of Kamasoun I. | 7 00 08 | 11 38 45 | ...... | ...... | ...... | ...... |
| | Cape Mount: W. peak ................ | 6 44 30 | 11 22 51 | ...... | ...... | ...... | ...... |
| | Cape Mesurado: Light-house .......... | 6 19 10 | 10 49 25 | ...... | ...... | ...... | ...... |
| | Monrovia: Light-house ............... | 6 19 00 | 10 50 00 | 5 40 | 11 54 | 6.0 | 2.5 |
| | Marshall: Agent's house.............. | 6 08 06 | 10 22 45 | ...... | ...... | ...... | ...... |
| | Grand Bassa: Agent's house........... | 5 54 08 | 10 04 05 | ...... | ...... | ...... | ...... |
| | Cestos: Factory .................... | 5 26 25 | 9 34 45 | ...... | ...... | ...... | ...... |
| | Sangwin River: Sangwin Pt .......... | 5 12 42 | 9 20 16 | ...... | ...... | ...... | ...... |
| | Sinon: Bloobarra Pt ................. | 4 59 15 | 9 02 05 | 4 50 | 11 05 | 4.8 | 2.0 |
| | Cape Palmas: Light-house ............ | 4 22 10 | 7 44 15 | 4 30 | 10 43 | 4.3 | 1.8 |
| | Tabou River: Tabou Pt .............. | 4 24 47 | 7 21 30 | ...... | ...... | ...... | ...... |
| | Axim Bay: Ft. St. Anthony........... | 4 52 18 | 2 14 45 | ...... | ...... | ...... | ...... |
| | Cape Three Points: Light-house ....... | 4 45 00 | 2 05 45 | 4 00 | 10 13 | 4.7 | 1.9 |
| | Dix Cove: Fort..................... | 4 47 45 | 1 56 40 | ...... | ...... | ...... | ...... |
| | Tacorady Bay: Tacorady Pt........... | 4 53 00 | 1 45 00 | ...... | ...... | ...... | ...... |
| | Chama Bay: Dutch Fort ............. | 5 01 00 | 1 38 00 | ...... | ...... | ...... | ...... |
| | El Mina Bay: Ft. St. George ......... | 5 04 48 | 1 21 05 | ...... | ...... | ...... | ...... |
| | Cape Coast Castle: Light-house ........ | 5 06 20 | 1 13 50 | 4 20 | 10 32 | 6.0 | 2.5 |
| | Accra: Light-house .................. | 5 31 50 | 0 11 30 | ...... | ...... | ...... | ...... |
| | | | Long. E. | | | | |
| | Volta River entrance: Dolbens Pt ...... | 5 46 00 | 0 41 00 | 4 20 | 10 33 | 4.2 | 1.8 |
| | Lagos River: Light-house ............. | 6 25 15 | 3 25 15 | 4 50 | 11 05 | 3.3 | 1.3 |
| | Benin River entrance: N. pt........... | 5 46 01 | 5 03 05 | ...... | ...... | ...... | ...... |
| | Brass River: Entrance (approx.) ....... | 4 16 40 | 6 15 00 | ...... | ...... | ...... | ...... |
| | Calebar River (New): Rough Corner ... | 4 23 07 | 7 07 00 | ...... | ...... | ...... | ...... |
| | Opobo River: W. pt. beacon (approx.).. | 4 27 00 | 7 40 00 | ...... | ...... | ...... | ...... |
| | Quaebo River: Bluff Pt .............. | 4 30 40 | 7 59 00 | ...... | ...... | ...... | ...... |
| | Calebar River (Old): Townsend flagstaff (Dunketown) ...................... | 4 56 24 | 8 20 46 | ...... | ...... | ...... | ...... |
| | Fernando Po Island: Light-house....... | 3 46 10 | 8 47 05 | ...... | ...... | ...... | ...... |
| | San Bento River: Joho Pt. (approx.) ... | 1 35 00 | 9 39 00 | ...... | ...... | ...... | ...... |
| | Princes Island: Diamond Rocks, center of largest........................ | 1 40 42 | 7 27 56 | ...... | ...... | ...... | ...... |
| | St. Thomas Island: Ft. San Sebastian light.............................. | 0 20 30 | 6 42 45 | ...... | ...... | ...... | ...... |
| | | Lat. S. | | | | | |
| | Anno Bon Island: Turtle Islet.......... | 1 24 18 | 5 38 12 | ...... | ...... | ...... | ...... |
| | Cape Lopez: Light-house............. | 0 36 25 | 8 43 10 | ...... | ...... | ...... | ...... |
| | Mayumba Bay: Light-house........... | 3 23 00 | 10 38 00 | 4 25 | 10 38 | 7.0 | 2.9 |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### WEST COAST OF AFRICA—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Loango Bay: Indian Pt. light .......... | 4 40 00 | 11 46 30 | 4 13 | 10 26 | 6.5 | 2.7 |
| | Black Point Bay: Sandy Pt ............. | 4 49 00 | 11 45 00 | ....... | ....... | ...... | ...... |
| | Malemba Bay: Landing Cove .......... | 5 18 30 | 12 08 00 | ....... | ....... | ...... | ...... |
| | Kabenda Bay: Kabenda Pt. light....... | 5 32 30 | 12 11 00 | ....... | ....... | ...... | ...... |
| | Congo River entrance: Shark Pt........ | 6 04 36 | 12 15 00 | 4 10 | 10 25 | 6.0 | 2.5 |
| | Margate Head: Summit................. | 6 31 50 | 12 25 25 | ....... | ....... | ...... | ...... |
| | St. Paul de Loando: Flag staff, Ft. San Miguel...... | 8 48 24 | 13 13 20 | 3 40 | 9 53 | 4.8 | 2.0 |
| | Lobito Point: Extreme.................. | 12 20 00 | 13 32 00 | ....... | ....... | ...... | ...... |
| | Benguela: Telegraph office............. | 12 34 43 | 13 23 45 | 3 30 | 9 43 | 5.5 | 2.3 |
| | Elephant Bay: Friar Rocks ............. | 13 12 30 | 12 48 55 | ....... | ....... | ...... | ...... |
| | St. Mary Bay: Bay I................... | 13 26 05 | 12 36 00 | ....... | : | ...... | ...... |
| | Little Fish Bay: Light-house .......... | 15 09 00 | 12 12 00 | ....... | ....... | ...... | ...... |
| | Port Alexander: Bateman Pt........... | 15 47 30 | 11 52 40 | ....... | ....... | ...... | ...... |
| | Great Fish Bay: Tiger Pt............... | 16 30 00 | 11 42 00 | 3 00 | 9 12 | 5.7 | 2.4 |
| | Cape Frio: Extreme ................... | 18 23 00 | 11 57 12 | ....... | ....... | ...... | ...... |
| | Walfisch Bay: Light-house ............ | 22 57 00 | 14 30 00 | ....... | ....... | ...... | ...... |
| | Ichabo Island ......................... | 26 17 00 | 14 57 20 | ....... | ....... | ...... | ...... |
| | Angra Pequena: Diaz Pt .............. | 26 37 52 | 15 07 02 | ....... | ....... | ...... | ...... |
| | Elizabeth Bay: S. pt. of Possession I.... | 26 58 30 | 15 12 22 | 2 35 | 8 47 | 5.5 | 2.3 |
| | Port Nolloth: Magistrate's house ....... | 29 15 12 | 16 52 02 | 2 25 | 8 38 | 5.3 | 2.2 |
| | Hondeklip Bay......................... | 30 18 33 | 17 16 20 | ....... | ....... | ...... | ...... |
| | Roodewal Bay......................... | 30 33 07 | 17 27 30 | ....... | ....... | ...... | ...... |
| | Saldanha Bay: Constable Hill.......... | 33 07 51 | 18 01 21 | 2 20 | 8 33 | 5.1 | 2.1 |
| | Table Bay: Robben I. light ............ | 33 48 52 | 18 22 33 | ....... | ....... | ...... | ...... |
| | Cape Town: Observatory................. | 33 56 04 | 18 28 40 | 1 36 | 7 47 | 4.6 | 2.0 |
| | Cape of Good Hope: Light-house ....... | 34 21 12 | 18 29 26 | ....... | ....... | ...... | ...... |

### EAST COAST OF AFRICA AND THE RED SEA.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | Simons Bay: Light-house ............. | 34 10 45 | 18 27 30 | 2 35 | 8 48 | 5.2 | 2.2 |
| | Cape Hangklip: Extreme ............. | 34 23 48 | 18 50 20 | ....... | ....... | ...... | ...... |
| | Quoin Point: Extreme................. | 34 46 45 | 19 38 17 | ....... | ....... | ...... | ...... |
| | Cape Agulhas: Light-house .......... | 34 49 45 | 20 00 37 | 2 40 | 8 53 | 5.2 | 2.2 |
| | Port Beaufort: Flag-staff............. | 34 23 47 | 20 48 40 | ....... | ....... | ...... | ...... |
| | St. Blaize: Light-house .............. | 34 11 10 | 22 09 31 | 3 18 | 9 31 | 5.6 | 2.0 |
| | Knysna Harbor: Fountain beacon ...... | 34 04 35 | 23 03 38 | ....... | ....... | ...... | ...... |
| | Plettenberg Bay: Summit of Seal Pt .... | 34 06 15 | 23 24 23 | ....... | ....... | ...... | ...... |
| | St. Francis: Light-house .............. | 34 12 30 | 24 50 20 | ....... | ....... | ...... | ...... |
| | Cape Recife: Light-house ............. | 34 01 41 | 25 42 12 | ....... | ....... | ...... | ...... |
| | Port Elizabeth: Light-house........... | 33 57 43 | 25 37 21 | 3 21 | 9 33 | 5.4 | 1.9 |
| | Bird Islands: Light-house............. | 33 50 27 | 26 17 13 | ....... | ....... | ...... | ...... |
| | Port Alfred: Signal staff.............. | 33 36 09 | 26 54 10 | ....... | ....... | ...... | ...... |
| | Waterloo Bay: Maitland Signal Hill .... | 33 28 00 | 27 03 00 | ....... | ....... | ...... | ...... |
| | Madagascar Reef: Center.............. | 33 23 10 | 27 20 48 | ....... | ....... | ...... | ...... |
| | Cove Rock: Center ................... | 33 05 10 | 27 49 12 | ....... | ....... | ...... | ...... |
| | East London: Light-house............. | 33 01 45 | 27 55 02 | 3 37 | 9 50 | 5.0 | 1.8 |
| | Cape Morgan: Extreme................. | 32 42 00 | 28 22 36 | ....... | ....... | ...... | ...... |
| | Hole-in-the-Wall .................... | 32 02 30 | 29 06 40 | ....... | ....... | ...... | ...... |
| | Rame Head: Extreme .................. | 31 48 15 | 29 21 15 | ....... | ....... | ...... | ...... |
| | Cape Hermes: Extreme................. | 31 38 06 | 29 33 16 | ....... | ....... | ...... | ...... |
| | Waterfall Bluff ....................... | 31 26 15 | 29 48 40 | ....... | ....... | ...... | ...... |
| | Port Natal (Durban): Light-house...... | 29 52 40 | 31 03 50 | 3 58 | 10 11 | 5.6 | 1.6 |
| | Dumford Point: Extreme .............. | 29 00 12 | 31 51 39 | ....... | ....... | ...... | ...... |
| | Cape St. Lucia: Extreme............... | 28 32 30 | 32 27 39 | ....... | ....... | ...... | ...... |
| | Cape Vidal: Extreme.................. | 28 09 36 | 32 38 10 | ....... | ....... | ...... | ...... |
| | Delagoa Bay: Reuben Pt. light ........ | 25 58 49 | 32 35 52 | 5 10 | 11 22 | 11.9 | 3.4 |
| | Cape Corrientes: Small rock........... | 24 05 30 | 35 29 45 | ....... | ....... | ...... | ...... |
| | Innamban Bay: Barrow Hill light ...... | 23 45 30 | 35 31 41 | 4 30 | 10 42 | 11.0 | 3.2 |
| | Cape St. Sebastian: Extreme........... | 22 05 00 | 35 29 00 | ....... | ....... | ...... | ...... |
| | Bazaruto Island: N. pt. light .......... | 21 31 00 | 35 29 30 | ....... | ....... | ...... | ...... |
| | Chuluwan Island: Light-house ........ | 20 38 10 | 34 53 30 | ....... | ....... | ...... | ...... |
| | Sofala: Fort on N. side of entrance...... | 20 10 42 | 34 46 00 | ....... | ....... | ...... | ...... |
| | Zambesi River: Kangoni Mouth ........ | 18 52 50 | 36 11 47 | 4 15 | 10 27 | 13.5 | 3.9 |
| | Quillimane River: Light-house ........ | 18 01 24 | 36 58 30 | ....... | ....... | ...... | ...... |
| | Quillimane: Town ................... | 17 51 50 | 37 01 09 | ....... | ....... | ...... | ...... |
| | Mazemba River: Entrance ............. | 17 15 00 | 38 04 00 | ....... | ....... | ...... | ...... |

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF AFRICA AND THE RED SEA—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Premeira Islands: Center of Casuarina I. | 17 06 30 | 39 06 27 | ........ | ........ | ........ | ........ |
| | Angoxa Islands: Center of Hurd I...... | 16 33 24 | 39 49 57 | ........ | ........ | ........ | ........ |
| | Mafamale Island: Center................ | 16 20 30 | 40 03 57 | ........ | ........ | ........ | ........ |
| | Port Mokamba: Mokambo Pt ........... | 15 08 00 | 40 36 12 | ........ | ........ | ........ | ........ |
| | Port Mozambique: St. George I. light... | 15 02 12 | 40 48 45 | ........ | ........ | ........ | ........ |
| | San Sebastian light.. | 15 00 45 | 40 45 06 | 4 00 | 10 12 | 11.8 | 3.4 |
| | Cape Cabeceira: Light-house ........... | 14 58 20 | 40 45 10 | ........ | ........ | ........ | ........ |
| | Port Conducia: Bar Pt................. | 14 53 00 | 40 40 00 | ........ | ........ | ........ | ........ |
| | Lurio Bay: Pando Pt .................. | 13 23 40 | 40 46 00 | ........ | ........ | ........ | ........ |
| | Pemba Bay: N. pt. light .............. | 12 55 45 | 40 31 15 | ........ | ........ | ........ | ........ |
| | Querimba Islands: Ibo I. light ........ | 12 19 30 | 40 40 09 | ........ | ........ | ........ | ........ |
| | Numba Island: E. pt .................. | 11 09 18 | 40 43 21 | ........ | ........ | ........ | ........ |
| | Cape Delgado: Light-house............. | 10 41 20 | 40 38 35 | 3 59 | 10 11 | 11.3 | 3.3 |
| | Msimbati: Ras Matunda ............... | 10 19 22 | 40 26 34 | ........ | ........ | ........ | ........ |
| | Mikindini Harbor: Kinizi.............. | 10 16 31 | 40 10 33 | ........ | ........ | ........ | ........ |
| | Mgan Mwania: Madjori Rock .......... | 10 06 43 | 40 02 14 | ........ | ........ | ........ | ........ |
| | Lindi River: Fort flagstaff .......... | 9 59 30 | 39 46 41 | 3 55 | 10 08 | 10.9 | 4.5 |
| | Mchinga Bay: Observation spot ........ | 9 44 22 | 39 47 07 | ........ | ........ | ........ | ........ |
| | Kiswere Harbor: Rustmigi.............. | 9 25 36 | 39 39 31 | ........ | ........ | ........ | ........ |
| | Kilwa Kisiwani: Fort.................. | 8 57 15 | 39 30 42 | ........ | ........ | ........ | ........ |
| | Mafia Island: Moresby Pt............. | 7 38 10 | 39 54 42 | ........ | ........ | ........ | ........ |
| | Dar-Es-Salaam: Flagstaff.............. | 6 49 41 | 39 17 05 | ........ | ........ | ........ | ........ |
| | Bagamoyo: French Mission ............ | 6 26 10 | 38 54 27 | ........ | ........ | ........ | ........ |
| | Zanzibar: English consulate............ | 6 09 43 | 39 11 08 | 4 05 | 10 17 | 14.5 | 6.0 |
| | Tanga Bay: Light-house ............... | 5 00 35 | 39 10 20 | ........ | ........ | ........ | ........ |
| | Mombasa: Light-house ................ | 4 04 30 | 39 41 13 | ........ | ........ | ........ | ........ |
| | Port Melinda: Vasco de Gama's Pillar .. | 3 12 48 | 40 11 21 | 4 00 | 10 13 | 12.1 | 5.0 |
| | Lamo Bay: Lamo Castle ............... | 2 15 42 | 40 56 21 | ........ | ........ | ........ | ........ |
| | Manda Roads: E. side of Manda Toto I . | 2 13 35 | 40 59 40 | ........ | ........ | ........ | ........ |
| | Port Durnford: Foot Pt.............. | 1 13 00 | 41 54 15 | 4 30 | 10 42 | 11.7 | 4.9 |
| | Kisimayu Bay: S. pt. of Kisimayu I.... | 0 22 35 | 42 33 57 | ........ | ........ | ........ | ........ |
| | | Lat. N. | | | | | |
| | Brava: Well ...... | 1 06 48 | 44 03 27 | 4 15 | 10 27 | 7.5 | 3.1 |
| | Meurka Anchorage: S. pt. of town...... | 1 42 06 | 44 53 49 | ........ | ........ | ........ | ........ |
| | Magadoxa: Tower...................... | 2 01 48 | 45 24 39 | ........ | ........ | ........ | ........ |
| | Murat Hill: Peak..................... | 2 30 00 | 46 07 00 | ........ | ........ | ........ | ........ |
| | Ras Hafun: E. extreme of Africa ....... | 10 26 30 | 51 22 55 | ........ | ........ | ........ | ........ |
| | Cape Guardafui: E. pt.................. | 11 50 30 | 51 16 45 | 6 00 | 12 12 | 6.1 | 2.5 |
| | Kal Farun Islet: Center ............... | 12 26 00 | 52 09 35 | ........ | ........ | ........ | ........ |
| | Abd-al-Kuri Island: NE. pt ........... | 12 11 15 | 52 25 35 | ........ | ........ | ........ | ........ |
| | Socotra Island: Tamarida, mosque...... | 12 39 00 | 53 59 31 | 7 05 | 1 17 | 7.5 | 3.1 |
| | Ras Antareh: Extreme of rocky pt ..... | 11 27 30 | 49 35 40 | ........ | ........ | ........ | ........ |
| | Máit Island: Center .................. | 11 13 00 | 47 17 00 | ........ | ........ | ........ | ........ |
| | Port Berbera: Light-house ............. | 10 25 00 | 44 59 35 | ........ | ........ | ........ | ........ |
| | Zeyla: Mosque ....................... | 11 22 00 | 43 29 35 | 7 30 | 1 18 | 8.5 | 3.5 |
| | Perim Island: Light-house ............. | 12 39 00 | 43 25 35 | 7 50 | 1 38 | 7.2 | 3.0 |
| Red Sea. | Hanfelah Bay: Hanfelah Pt............. | 14 44 00 | 40 52 00 | ........ | ........ | ........ | ........ |
| | Disei Island: Village Bay ............. | 15 28 10 | 39 45 30 | ........ | ........ | ........ | ........ |
| | Massaua Harbor: N. pt. of entrance .... | 15 37 12 | 39 27 23 | 0 45 | 6 57 | 4.0 | 1.7 |
| | Khôr Nowarat: Shatireh Islet .......... | 18 15 12 | 38 19 30 | ........ | ........ | ........ | ........ |
| | Suakin: Light-house................... | 19 07 00 | 37 19 09 | 2 10 | 8 22 | 1.7 | 0.7 |
| | Makaua Island: S. pt ................. | 20 44 00 | 37 15 30 | ........ | ........ | ........ | ........ |
| | St. Johns Island: Peak ............... | 23 36 20 | 36 10 15 | ........ | ........ | ........ | ........ |
| | Dædalus Shoal: Light-house ........... | 24 56 30 | 35 51 00 | ........ | ........ | ........ | ........ |
| | Kosair Anchorage: SW. angle of fort.... | 26 06 24 | 34 17 03 | ........ | ........ | ........ | ........ |
| | Brothers Island: Light-house........... | 26 18 50 | 34 50 45 | 6 40 | 0 28 | 2.0 | 0.8 |
| | Safajah Island: N. summit ............ | 26 45 48 | 33 59 43 | ........ | ........ | ........ | ........ |
| | Ashrafi Island: Light-house............ | 27 47 21 | 33 42 28 | ........ | ........ | ........ | ........ |
| | Ras Gharib: Light-house.............. | 28 20 52 | 33 06 31 | 10 35 | 4 23 | 1.5 | 0.6 |
| | Zafarana: Light-house ................ | 29 06 29 | 32 39 43 | 10 40 | 4 28 | 5.5 | 2.3 |
| | Suez: Newport Rock................... | 29 53 05 | 32 32 50 | 10 45 | 4 32 | 6.8 | 2.8 |
| | Tôr: Ruined fort ..................... | 28 13 47 | 33 36 56 | ........ | ........ | ........ | ........ |
| | Sherm Yahar: Entrance............... | 27 35 45 | 35 30 30 | ........ | ........ | ........ | ........ |
| | Sherm Joobbah: Entrance ............. | 27 33 00 | 35 32 30 | ........ | ........ | ........ | ........ |
| | Sherm Wej: Light-house............... | 26 13 00 | 36 27 00 | ........ | ........ | ........ | ........ |
| | Sherm Hassejy: Anchorage ............ | 24 38 35 | 37 17 45 | ........ | ........ | ........ | ........ |
| | Yembó: Anchorage.................... | 24 05 15 | 38 02 45 | ........ | ........ | ........ | ........ |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF AFRICA AND THE RED SEA—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Red Sea. | Sherm Rabigh: Anchorage | 22 43 50 | 39 00 30 | ........ | ........ | .... | .... |
| | Jiddah: Jezirah el Mifsaka I | 21 28 00 | 39 10 38 | 3 30 | 9 42 | 2.0 | 0.8 |
| | Lith: Agha Islet | 20 09 00 | 40 12 00 | ........ | ........ | .... | .... |
| | Jelalil: Anchorage | 19 55 30 | 40 30 00 | ........ | ........ | .... | .... |
| | Kunfidah: Islet | 19 07 40 | 41 03 20 | ........ | ........ | .... | .... |
| | Khôr Nohud: Entrance | 18 15 50 | 41 27 30 | ........ | ........ | .... | .... |
| | Farisan I. Anchorage: Jebel Mandhakh | 16 50 15 | 41 58 15 | ........ | ........ | .... | .... |
| | Gizau: Fort | 16 53 00 | 42 29 00 | ........ | ........ | .... | .... |
| | Loheiya: Hill Fort | 15 42 00 | 42 38 45 | 1 15 | 7 27 | 2.9 | 1.2 |
| | Kamarán Bay: Harbor | 15 20 30 | 42 34 00 | ........ | ........ | .... | .... |
| | Hodeïda Road | 14 47 00 | 42 56 00 | ........ | ........ | .... | .... |
| | Jebel Zukur Island: N. pt | 14 03 53 | 42 45 28 | ........ | ........ | .... | .... |
| | Mokha: N. Fort | 13 19 43 | 43 13 36 | 11 45 | 5 33 | 4.5 | 1.9 |

### ISLANDS OF THE INDIAN OCEAN.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| Laccadive Islands. | Chitlac Islet: S. end | 11 40 45 | 72 42 54 | ........ | ........ | .... | .... |
| | Betrapar Islet: N. Island | 11 35 00 | 72 09 54 | ........ | ........ | .... | .... |
| | Kittan Islet: S. end | 11 27 30 | 72 59 00 | 10 20 | 4 00 | 6.3 | 3.0 |
| | Cardamum Islet: Center | 11 13 00 | 72 44 00 | ........ | ........ | .... | .... |
| | Ameni Islet: N. end | 11 06 00 | 72 41 00 | ........ | ........ | .... | .... |
| | Underut Islet: Center | 10 47 00 | 73 40 00 | .. | ........ | .... | .... |
| | Cabrut Islet: E. end | 10 32 00 | 72 37 40 | ........ | ........ | .... | .... |
| | Seuheli Par: N. islet | 10 06 00 | 72 15 10 | ........ | ........ | .... | .... |
| | Kalpeni Islet: S. end | 10 03 00 | 73 35 54 | ........ | ........ | .... | .... |
| | Minikoi Island: Light-house | 8 16 00 | 73 01 15 | 11 27 | 5 15 | 2.5 | 1.2 |
| Maldive Islands. | Heawandu Island: S. end | 6 55 00 | 72 55 54 | ........ | ........ | .... | .... |
| | Kee-lah Island: N. end | 6 59 00 | 73 12 54 | ........ | ........ | .... | .... |
| | Mah Kundu Island: NE. extreme | 6 25 00 | 72 41 54 | ........ | ........ | .... | .... |
| | Nar Foree Island | 5 26 30 | 73 20 00 | ........ | ........ | .... | .... |
| | Hee-tah-doo Island | 5 01 30 | 72 53 00 | ........ | ........ | .... | .... |
| | To-du Island: Center | 4 25 45 | 72 57 24 | ........ | ........ | .... | .... |
| | Gafor Island: Center | 4 44 00 | 73 28 00 | ........ | ........ | .... | .... |
| | Malé, or Kings Island: Flagstaff | 4 10 15 | 73 30 24 | 0 20 | 6 25 | 2.9 | 1.4 |
| | Pha-li-du Island: Northern end | 3 41 00 | 73 24 54 | ........ | ........ | .... | .... |
| | Moluk Island: Center | 2 57 00 | 73 34 24 | ........ | ........ | .... | .... |
| | Himmittee Island | 3 16 00 | 72 48 00 | ........ | ........ | .... | .... |
| | Kimbeedso Island: S. end | 2 10 30 | 73 03 00 | ........ | ........ | .... | .... |
| | Esdu Island: NE. pt | 2 07 00 | 73 35 54 | ........ | ........ | .... | .... |
| | Wahdu Island: E. end | 0 14 30 | 73 13 00 | ........ | ........ | .... | .... |
| | | Lat. S. | | | | | |
| | Addu Atoll: Gung I | 0 41 30 | 73 06 54 | ........ | ........ | .... | .... |
| | Amirante Islands: Ile des Roches, N. beach | 5 40 56 | 53 41 03 | ........ | ........ | .... | .... |
| | African Islands | 4 52 26 | 53 23 38 | | | | |
| | Seychelle Is., Platte I.: S. end | 5 53 00 | 55 27 10 | | | | |
| | Port Victoria: End of Hodoul Jetty | 4 37 15 | 55 27 23 | 4 22 | 10 35 | 4.3 | 1.2 |
| | Bird Island: Tree | 3 43 06 | 55 12 19 | | | | |
| | Chagos Archipelago, Peros Banhos: Diamond Islet | 5 15 00 | 71 43 47 | ........ | ........ | .... | .... |
| | Diego Garcia: N. end of Middle I | 7 13 37 | 72 23 50 | 1 30 | 7 43 | 5.8 | 1.7 |
| | Cargados Carajos: Establishment I., flagstaff | 16 25 12 | 59 46 40 | 1 50 | 8 03 | 4.0 | 1.2 |
| | Rodriguez Island: Mathurina Bay, Point Venus | 19 40 22 | 63 25 38 | 0 20 | 6 32 | 5.5 | 1.6 |
| Mauritius I. | Flat Island: Light-house | 19 52 36 | 57 39 14 | ........ | ........ | .... | .... |
| | Cannonier Point: Light-house | 19 59 45 | 57 32 35 | | | | |
| | Port Louis: Martello tower, Ft. George | 20 08 46 | 57 29 26 | 0 48 | 7 00 | 1.6 | 0.3 |
| | Grand Port: Fouquet I. light | 20 24 20 | 57 47 14 | ........ | ........ | .... | .... |

MARITIME POSITIONS AND TIDAL DATA.

## ISLANDS OF THE INDIAN OCEAN—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Réunion Island: St. Denis light ......... | 20 51 38 | 55 26 59 | ........ | ........ | ........ | ........ |
| | Bel-Air light ........... | 20 53 11 | 55 36 18 | ........ | ........ | ........ | ........ |
| | St. Paul light........... | 20 59 45 | 55 16 18 | ........ | ........ | ........ | ........ |
| | St. Pierre light ........ | 21 19 47 | 55 28 58 | 11 50 | 5 38 | 3.5 | 0.6 |
| | Tromelin Island: N. end ............... | 15 51 37 | 54 28 46 | ........ | ........ | ........ | ........ |
| | Agalegas Island: NW. pt................. | 10 21 30 | 56 32 00 | ........ | ........ | ........ | ........ |
| | Farquhar Islands: Hall's house.`........ | 10 06 45 | 51 10 21 | ........ | ........ | ........ | ........ |
| | Alphonse Island: SE. part (Trees)....... | 7 00 30 | 52 44 57 | ........ | ........ | ........ | ........ |
| | Coetivy Island: N. end ................. | 7 06 00 | 56 22 00 | ........ | ........ | ........ | ........ |
| | | | | | | | |
| | Cape St. Mary: S. extreme.............. | 25 39 10 | 45 06 50 | ........ | ........ | ........ | ........ |
| | Leven Island: Center .................. | 25 12 30 | 44 17 57 | ........ | ........ | ........ | ........ |
| | Port Machikora: Barracouta I.......... | 25 03 00 | 44 07 20 | ........ | ........ | ........ | ........ |
| | St. Augustine Bay: Nosi Vei I.......... | 23 38 25 | 43 38 20 | 5 40 | 11 52 | 9.8 | 2.9 |
| | Murderers Bay: Center of Murder I..... | 22 05 18 | 43 15 20 | ........ | ........ | ........ | ........ |
| | Cape St. Vincent: Extreme ............ | 21 54 24 | 43 20 21 | ........ | ........ | ........ | ........ |
| | Mourondava: Village .................... | 20 18 18 | 44 19 21 | ........ | ........ | ........ | ........ |
| | Tsmano: Village ....................... | 19 49 30 | 44 31 30 | ........ | ........ | ........ | ........ |
| | Kovra Rythi Point: Extreme............ | 17 53 00 | 44 02 20 | ........ | ........ | ........ | ........ |
| | Coffin Island: Nosi Vao ............... | 17 29 00 | 43 45 18 | ........ | ........ | ........ | ........ |
| | Cape St. Andrew: Extreme ............ | 16 12 10 | 44 29 05 | ........ | ........ | ........ | ........ |
| Madagascar. | Boyanna Bay: Barabata Pt............ | 16 07 00 | 45 17 09 | ........ | ........ | ........ | ........ |
| | Cape Tauzon: Extreme ................ | 15 46 30 | 45 43 09 | ........ | ........ | ........ | ........ |
| | Majunga (Mojanga): Light-house....... | 15 43 45 | 46 18 45 | 4 15 | 11 28 | 10.9 | 3.2 |
| | Majamba Bay: W. pt .................. | 15 11 42 | 46 57 29 | ........ | ........ | ........ | ........ |
| | Narendri Bay: Moormora Pt ........... | 14 40 18 | 47 24 36 | ........ | ........ | ........ | ........ |
| | Port Radama: Pt. Blair ............... | 13 59 00 | 47 58 21 | ........ | ........ | ........ | ........ |
| | Radama Islands: N. pt. Nossuvee I ..... | 13 55 40 | 47 48 05 | ........ | ........ | ........ | ........ |
| | Baratoube Bay: Ambubuka Pt.......... | 13 27 15 | 47 59 30 | ........ | ........ | ........ | ........ |
| | Nosi Bé: Hellville jetty................. | 13 23 38 | 48 17 34 | ........ | ........ | ........ | ........ |
| | Minow Islands: N. pt. Great I......... | 12 49 30 | 48 38 57 | ........ | ........ | ........ | ........ |
| | Cape San Sebastian: Extreme ......... | 12 27 20 | 48 45 45 | ........ | ........ | ........ | ........ |
| | Port Liverpool: N. pt. of entrance ..... | 12 03 18 | 49 11 21 | ........ | ........ | ........ | ........ |
| | Cape Amber: NE. extreme............. | 11 57 30 | 49 17 25 | ........ | ........ | ........ | ........ |
| | Port Lady Frances: Sunson Pt.......... | 12 23 20 | 49 35 56 | ........ | ........ | ........ | ........ |
| | Port Looké: Pt. Bathurst ............. | 12 44 02 | 49 45 06 | ........ | ........ | ........ | ........ |
| | Port Leven: S. pt. Nosi Hau I......... | 12 49 00 | 49 54 00 | ........ | ........ | ........ | ........ |
| | Andrava Bay: Berry Head ............ | 12 56 48 | 49 56 25 | ........ | ........ | ........ | ........ |
| | Vohemar: Flagstaff.................... | 13 21 15 | 50 01 59 | ........ | ........ | ........ | ........ |
| | Cape East: Ugoncy I.................. | 15 15 48 | 50 31 21 | ........ | ........ | ........ | ........ |
| | Venangue Bé Bay: Entrance .......... | 15 54 50 | 50 16 05 | ........ | ........ | ........ | ........ |
| | Port Choiseul: Maran Seelzy Village.... | 15 27 55 | 49 49 11 | 3 45 | 9 57 | 5.1 | 1.5 |
| | Cape Bellone: Extreme ................ | 16 14 00 | 49 50 59 | ........ | ........ | ........ | ........ |
| | St. Marys Island: Light on Madame I .. | 17 00 05 | 49 50 59 | ........ | ........ | ........ | ........ |
| | Port Tantang: Flagstaff ............... | 16 42 30 | 49 56 15 | ........ | ........ | ........ | ........ |
| | Fenerive Point: Flagstaff............... | 17 23 16 | 49 32 04 | ........ | ........ | ........ | ........ |
| | Tamatave: Pt. Hastie.................. | 18 09 47 | 49 25 31 | 4 00 | 10 12 | 7.3 | 2.1 |
| | Mahanuru: Town ..................... | 19 55 00 | 48 52 10 | ........ | ........ | ........ | ........ |
| | Matatane: Village ..................... | 21 58 10 | 48 14 50 | ........ | ........ | ........ | ........ |
| | Santa Lucia: N. end of town, Obs. Rock. | 24 46 25 | 47 10 34 | ........ | ........ | ........ | ........ |
| | Point Ytapere: Extreme ............... | 24 59 42 | 47 07 20 | ........ | ........ | ........ | ........ |
| | Ytapere Bay: N. pt.................... | 24 58 50 | 47 04 24 | ........ | ........ | ........ | ........ |
| | Fort Dauphin: Flagstaff................ | 25 01 30 | 46 59 11 | 4 15 | 10 27 | 4.7 | 1.3 |
| | | | | | | | |
| | Europa Island: Center.................. | 22 22 30 | 40 24 10 | ........ | ........ | ........ | ........ |
| | Bassas da India: E. pt................. | 21 29 00 | 39 40 39 | ........ | ........ | ........ | ........ |
| | Geyser Reef: SE. extreme.............. | 12 26 30 | 46 32 35 | ........ | ........ | ........ | ........ |
| | Mayotta Island: Zaoudzi............... | 12 47 02 | 45 16 27 | 4 00 | 10 13 | 11.9 | 2.0 |
| | Johanna Island: Landing place, Pomoni Harbor ...... | 12 16 20 | 44 24 54 | ........ | ........ | ........ | ........ |
| | Mohilla Island: Numa Choa Harbor.... | 12 25 00 | 43 47 00 | ........ | ........ | ........ | ........ |
| | Glorioso Island: W. islet ............. | 11 34 40 | 47 24 09 | ........ | ........ | ........ | ........ |
| | Comoro Island: Islet in Mauroni Bay ... | 11 40 44 | 43 19 15 | 4 45 | 10 58 | 10.0 | 1.7 |
| | Assumption Island: Hummock......... | 9 46 20 | 46 31 07 | ........ | ........ | ........ | ........ |
| | Aldabra Island: West I., E. side entrance. | 9 22 35 | 46 14 52 | ........ | ........ | ........ | ........ |
| | Cosmoledo Islands: Observation islet.... | 9 41 20 | 47 32 25 | ........ | ........ | ........ | ........ |

MARITIME POSITIONS AND TIDAL DATA.

### ISLANDS OF THE INDIAN OCEAN—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Prince Edwards Islands: Marion I., Obs. spot, NE. side | 46 49 30 | 37 49 15 | | | | |
| **Crozet Is.** | Penguin Islands: Center of SW. islet | 46 36 00 | 50 41 30 | | | | |
| | Possession Island: NW. pt | 46 22 00 | 51 30 15 | | | | |
| | Twelve Islands: Summit NE. I | 46 01 00 | 50 40 00 | | | | |
| | Navire Bay | 46 28 18 | 51 50 00 | | | | |
| | Hog Island: Summit | 46 10 40 | 50 35 00 | | | | |
| | East Island: Center | 46 26 00 | 52 13 00 | | | | |
| **Kerguelen Is.** | Christmas Harbor | 48 40 00 | 69 04 00 | | | | |
| | Blighs Cape | 48 26 45 | 68 48 20 | | | | |
| | Cape Bourbon | 49 42 00 | 68 54 00 | | | | |
| | Molloy, Port Royal Sound: U. S. Tr. of Venus Obs., 1874 | 49 21 22 | 70 04 31 | 0 14 | 6 36 | 4.6 | 1.3 |
| | Cape Challenger | 49 41 00 | 70 15 00 | | | | |
| | Balfour Rock | 49 29 00 | 70 29 50 | | | | |
| | Heard Island: Cape Laurens, NW. end | 53 02 45 | 73 15 30 | | | | |
| | Sealing station | 53 13 00 | 73 52 00 | | | | |
| | McDonald Island, Summit | 53 02 50 | 72 31 45 | | | | |
| | St. Pauls Island: Ninepin Rock | 38 42 51 | 77 31 53 | 10 40 | 4 28 | 3.0 | 0.9 |
| | Amsterdam Island: Summit, 2,750 feet | 37 50 00 | 77 29 15 | 10 50 | 4 38 | 3.3 | 1.0 |
| | Keeling or Cocos Islands: Direction I | 12 06 22 | 96 53 02 | 5 20 | 11 32 | 5.1 | 1.5 |
| | Christmas Island: Flying Fish Cove | 10 25 19 | 105 45 57 | 7 10 | 1 00 | 4.5 | 1.3 |

### SOUTH COAST OF ASIA.

| Coast. | Place. | Lat. N. | Long. E. | H. W. | L. W. | Spg. | Neap. |
|---|---|---|---|---|---|---|---|
| **Arabia.** | Aden: Telegraph station | 12 47 16 | 44 59 07 | 7 49 | 1 41 | 4.9 | 2.0 |
| | Sughra: Sheik's house | 13 22 00 | 45 40 50 | | | | |
| | Mokatein: Black ruin | 13 24 50 | 46 26 35 | | | | |
| | Howaiyuh: Sheik's house | 13 28 45 | 46 39 00 | | | | |
| | Banderburum: SE. house of town | 14 20 10 | 48 56 45 | | | | |
| | Makalleh Bay: Flagstaff | 14 31 15 | 49 07 35 | 8 20 | 2 07 | 6.8 | 2.8 |
| | Shahah Roads: Custom-house | 14 43 50 | 49 35 05 | | | | |
| | Sharmoh: Single house | 14 49 00 | 49 57 05 | | | | |
| | Kosair: High house | 14 54 40 | 50 16 35 | | | | |
| | Sihut: Center of town | 15 12 00 | 51 10 30 | | | | |
| | Ras Fartak: Extreme pt | 15 38 00 | 52 14 20 | | | | |
| | Damghot: Town | 16 30 00 | 52 48 00 | | | | |
| | Merbat: Town | 16 59 00 | 54 43 29 | 8 50 | 2 38 | 7.0 | 2.9 |
| | Kuria Maria Is., Hullaniyeh I.: NE. bluff | 17 32 45 | 56 03 05 | | | | |
| | Ras Sherbedat: Point | 17 53 15 | 56 20 35 | | | | |
| | Cape Isolette: Islet | 19 00 25 | 57 51 35 | | | | |
| | Masirah Island: Point Abu-Rasas | 20 10 00 | 58 38 35 | | | | |
| | Point Ras Ye | 20 31 30 | 58 58 35 | 9 45 | 3 32 | 9.6 | 4.4 |
| | Ras-al-Hed: Extreme pt | 22 32 40 | 59 48 35 | 9 15 | 3 03 | 8.9 | 4.1 |
| | Maskat (Muscat): Maskat Pt | 23 38 00 | 58 30 50 | 9 30 | 3 20 | 6.0 | 2.8 |
| | Deimaniyeh Islands: E. islet | 23 52 00 | 58 08 00 | | | | |
| | Sueik: Fort | 23 51 30 | 57 26 00 | | | | |
| | Sohar: SE. tower of town hall | 24 21 50 | 56 46 12 | | | | |
| | Khaur Fakan Bay: W. end of village | 25 21 00 | 56 22 56 | | | | |
| | Ras Musendom: N. end of island | 26 24 13 | 56 32 22 | | | | |
| | Great Quoin Islet: Center | 26 30 00 | 56 31 29 | | | | |
| | Sharjah: High tower with flagstaff | 25 21 34 | 55 24 12 | | | | |
| | Abu-Thabi: Fort flagstaff | 24 29 02 | 54 22 14 | | | | |
| | Al Beda'a Harbor: Nessah Pt., N. extreme | 25 17 24 | 51 33 32 | | | | |
| | Ras Rakkin: NW. pt | 26 10 55 | 51 13 46 | | | | |
| | Bahrain Harbor: Portuguese fort | 26 13 56 | 50 32 17 | 5 15 | 11 30 | 6.4 | 3.7 |
| | Basrah: Custom-house flagstaff | 30 32 00 | 47 51 23 | | | | |
| | Kuweit Harbor: N. end of town | 29 22 56 | 48 00 55 | 0 05 | 6 17 | 8.3 | 4.8 |
| **Persia.** | Khárig Islet: Fort flagstaff | 29 15 25 | 50 21 11 | | | | |
| | Abu Shahr: Residency flagstaff | 28 59 07 | 50 50 35 | 7 12 | 1 13 | 2.6 | 1.5 |
| | Shaikh Shu'aib Islet: E. end | 26 47 40 | 53 23 36 | | | | |
| | Kais Islet: NE. pt | 26 33 37 | 54 02 21 | 0 30 | 6 40 | 6.6 | 3.8 |

## MARITIME POSITIONS AND TIDAL DATA.

### SOUTH COAST OF ASIA—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Persia. | Básidúh: Chapel | 26 39 12 | 55 16 47 | ........ | ........ | ...... | ...... |
| | Haujam Islet: Ruined mosque | 26 40 49 | 55 54 25 | ........ | ........ | ...... | ...... |
| | Kasm: Fort | 26 57 27 | 56 17 37 | 10 50 | 4 35 | 11. 6 | 5. 3 |
| | Jashak Bay: Telegraph office | 25 38 19 | 57 46 14 | 9 20 | 3 05 | 7. 8 | 3. 6 |
| | Kub Kalat: High peak, 1,680 feet | 25 29 45 | 59 40 32 | ........ | ........ | ...... | ...... |
| | Chahbar Bay: Telegraph office | 25 16 43 | 60 37 40 | ........ | ........ | ...... | ...... |
| | Gwatar Bay: Islet | 25 03 17 | 61 26 24 | ........ | ........ | ...... | ...... |
| Baluchistan. | Gwadar Bay: Telegraph office | 25 07 19 | 62 19 42 | 9 20 | 3 05 | 8. 1 | 3. 7 |
| | Pasni: Telegraph office | 25 15 52 | 63 28 37 | ........ | ........ | ...... | ...... |
| | Ormarah: Telegraph office | 25 11 55 | 64 37 02 | ........ | ........ | ...... | ...... |
| | Sunmiyani: Jam's house | 25 25 19 | 66 35 39 | 8 50 | 2 35 | 8. 1 | 3. 8 |
| | Cape Monze: Peak | 24 50 03 | 66 39 58 | ........ | ........ | ...... | ...... |
| India. | Karachi: Manora light | 24 47 37 | 66 58 06 | 10 15 | 4 00 | 7. 3 | 3. 4 |
| | Observatory | 24 49 50 | 67 01 33 | ........ | ........ | ...... | ...... |
| | Mandavi: Light-house | 22 50 00 | 69 20 15 | ........ | ........ | ...... | ...... |
| | Beyt (Bet): Light-house | 22 29 20 | 69 04 40 | 12 05 | 5 39 | 10. 8 | 5. 2 |
| | Dwarka: Light-house | 22 14 00 | 68 57 06 | ........ | ........ | ...... | ...... |
| | Temple spire | 22 14 00 | 68 58 54 | ........ | ........ | ...... | ...... |
| | Porebander: Light-house | 21 38 00 | 69 36 00 | ........ | ........ | ...... | ...... |
| | Mangarol: Light-house | 21 06 00 | 70 06 32 | ........ | ........ | ...... | ...... |
| | Diu Head: Light-house | 20 41 20 | 70 50 45 | ........ | ........ | ...... | ...... |
| | Kutpur: Light-house | 21 02 21 | 71 49 35 | ........ | ........ | ...... | ...... |
| | Bhaunagar: Light-house | 21 47 00 | 72 14 00 | 4 27 | 11 18 | 29. 8 | 15. 1 |
| | Perim Island: Light-house | 21 35 54 | 72 21 08 | ........ | ........ | ...... | ...... |
| | Cambay: Flagstaff | 22 17 00 | 72 35 10 | ........ | ........ | ...... | ...... |
| | Surat River: Tapti light | 21 05 20 | 72 38 40 | ........ | ........ | ...... | ...... |
| | Surat: Minaret Adrusah | 21 12 19 | 72 49 27 | ........ | ........ | ...... | ...... |
| | Bassein: Center of town | 19 20 10 | 72 48 44 | ........ | ........ | ...... | ...... |
| | Bombay: Observatory | 18 53 45 | 72 48 56 | 11 26 | 5 08 | 12. 0 | 4. 9 |
| | Kenery Island light | 18 42 08 | 72 48 49 | ........ | ........ | ...... | ...... |
| | Bankot: Fort Victoria | 17 58 00 | 73 02 40 | ........ | ........ | ...... | ...... |
| | Ratnagherry: Fort | 16 59 30 | 73 15 56 | ........ | ........ | ...... | ...... |
| | Viziadrug: Fort flagstaff | 16 33 26 | 73 19 39 | ........ | ........ | ...... | ...... |
| | Cape Ramas: W. bastion of fort | 15 05 12 | 73 54 50 | ........ | ........ | ...... | ...... |
| | Goa: St. Denis Church | 15 21 24 | 73 54 00 | ........ | ........ | ...... | ...... |
| | Agaada light | 15 29 25 | 73 46 10 | 10 34 | 4 10 | 5. 2 | 2. 5 |
| | Vingorla: Signal-station light | 15 51 10 | 73 37 00 | ........ | ........ | ...... | ...... |
| | Vingorla Rocks: Light-house | 15 53 20 | 73 27 15 | ........ | ........ | ...... | ...... |
| | Sedashigar Bay: Oyster Rock light | 14 49 00 | 74 03 40 | 10 34 | 4 11 | 5. 0 | 2. 4 |
| | Kumpta: Light-house | 14 25 00 | 74 22 30 | ........ | ........ | ...... | ...... |
| | Hináwar: Monument | 14 17 28 | 74 26 40 | ........ | ........ | ...... | ...... |
| | Kundapur: Light-house | 13 38 15 | 74 39 50 | ........ | ........ | ...... | ...... |
| | Mangalore: Light-house | 12 52 17 | 74 50 40 | 10 50 | 4 28 | 6. 5 | 3. 4 |
| | Kannanur: Light-house | 11 51 10 | 75 21 51 | ........ | ........ | ...... | ...... |
| | Tellicherri: Flagstaff | 11 45 00 | 75 29 40 | ........ | ........ | ...... | ...... |
| | Mahé: Light-house | 11 42 00 | 75 31 10 | ........ | ........ | ...... | ...... |
| | Calicut: Light-house | 11 15 10 | 75 46 40 | 11 21 | 4 59 | 2. 7 | 1. 4 |
| | Cochin: Light-house | 9 58 00 | 76 14 40 | 11 33 | 5 06 | 2. 1 | 1. 0 |
| | Alipee: Light-house | 9 30 00 | 76 20 40 | ........ | ........ | ...... | ...... |
| | Quilon: Tongacherri Point light | 8 53 20 | 76 34 00 | 0 18 | 6 16 | 2. 5 | 1. 3 |
| | Trevandrum: Observatory | 8 30 47 | 76 56 45 | ........ | ........ | ...... | ...... |
| | Cape Comorin: Light-house | 8 04 00 | 77 32 35 | ........ | ........ | ...... | ...... |
| | Trichendore: Pagoda on pt | 8 29 55 | 78 07 47 | ........ | ........ | ...... | ...... |
| | Tuticorin: Light-house | 8 47 10 | 78 11 26 | 1 52 | 7 51 | 3. 0 | 0. 8 |
| | Paumben Pass: Light-house | 9 17 20 | 79 12 50 | 1 37 | 7 36 | 2. 0 | 0. 5 |
| Ceylon. | Manaar: Center of town | 8 59 00 | 79 53 52 | ........ | ........ | ...... | ...... |
| | Colombo: Light-house | 6 55 40 | 79 50 40 | 1 55 | 7 49 | 2. 0 | 0. 4 |
| | Dondra Head: Light-house | 5 55 30 | 80 34 12 | ........ | ........ | ...... | ...... |
| | Point de Galle: Light-house | 6 01 25 | 80 13 04 | 2 02 | 8 07 | 1. 9 | 0. 4 |
| | Great Bassas Rocks: Light-house | 6 10 10 | 81 28 15 | ........ | ........ | ...... | ...... |
| | Little Bassas Rocks: Light-house | 6 25 00 | 81 44 00 | ........ | ........ | ...... | ...... |
| | Batticaloa: Light-house | 7 45 00 | 81 41 00 | ........ | ........ | ...... | ...... |
| | Trincomali: Dock-yard flagstaff | 8 33 30 | 81 13 42 | 8 10 | 1 44 | 2. 0 | 0. 5 |
| India. | Calimere Point: Light-house | 10 18 00 | 79 51 30 | ........ | ........ | ...... | ...... |
| | Negapatam: Light-house | 10 45 28 | 79 50 47 | 8 37 | 2 37 | 2. 1 | 0. 9 |
| | Pondicherri: Light-house | 11 55 40 | 79 50 10 | ........ | ........ | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

**SOUTH COAST OF ASIA—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **India.** | Madras: Observatory | 13 04 06 | 80 14 51 | | | | |
| | Light-house | 13 05 15 | 80 17 00 | 8 41 | 2 26 | 3. 1 | 1. 2 |
| | Pulicat: Light-house | 13 25 15 | 80 19 12 | | | | |
| | Armeghon: Light-house | 13 53 08 | 80 12 30 | | | | |
| | Kistna: Light-house | 15 47 00 | 80 59 00 | | | | |
| | Masulipatam: Flagstaff | 16 09 45 | 81 11 00 | | | | |
| | Coconada: Light-house | 16 56 21 | 82 15 05 | 8 42 | 2 35 | 4. 5 | 1. 9 |
| | Vizagapatam: Fort flagstaff | 17 41 34 | 83 17 42 | 8 48 | 2 34 | 4. 4 | 1. 8 |
| | Kalingapatam: Light-house | 18 19 00 | 84 07 30 | | | | |
| | Gopalpur: Light-house | 19 13 00 | 84 52 06 | | | | |
| | Gaujam: Fort | 19 22 30 | 85 03 29 | | | | |
| | Juggernath: Great temple | 19 48 17 | 85 49 09 | | | | |
| | False Point: Light-house | 20 20 20 | 86 44 00 | 9 21 | 3 00 | 6. 8 | . 2. 6 |
| | Balasor River: Chandipur light | 21 27 15 | 87 02 20 | | | | |
| | Saugor Island: Light-house | 21 38 40 | 88 02 00 | | | | |
| | Diamond Harbor: Flagstaff | 22 11 10 | 88 11 07 | | | | |
| | Calcutta: Ft. William semaphore | 22 33 25 | 88 20 12 | 1 25 | 9 06 | 11. 2 | 4. 4 |
| **Burma.** | Chittagong River: Light-house | 22 11 00 | 91 49 00 | 1 02 | 7 56 | 13. 1 | 5. 6 |
| | Akyab: Oyster Reef light | 20 05 00 | 92 39 00 | | | | |
| | Old temple | 20 08 53 | 92 52 40 | 9 40 | 3 28 | 7. 6 | 3. 0 |
| | Ramree Island: S. pt | 18 51 00 | 93 56 30 | | | | |
| | Chedubah Island: NW. peak | 18 50 30 | 93 31 00 | | | | |
| | Cape Negrais: Extreme | 16 01 30 | 94 13 16 | | | | |
| | Bassein River: Alguada Reef light | 15 42 14 | 94 12 00 | | | | |
| | Bassein: Port Dalhousie | 16 01 30 | 94 23 00 | 3 05 | 9 55 | 18. 7 | 7. 8 |
| | Andaman Is.: Table Id., Light-house | 14 12 30 | 93 22 30 | | | | |
| | Port Cornwallis, Rock in entrance | 13 18 40 | 92 57 10 | 9 50 | 3 37 | 8. 6 | 2. 9 |
| | Port Blair, Light-house | 11 40 40 | 92 45 15 | 9 40 | 3 27 | 6. 3 | 2. 1 |
| | Little Andaman Island, SE. pt | 10 27 00 | 92 31 10 | | | | |
| | Krishna Shoal: Light vessel | 15 37 26 | 95 37 32 | | | | |
| | Rangoon River: Grove Pt. light | 16 30 01 | 96 23 00 | | | | |
| | Rangoon: Great Dagon pagoda | 16 46 00 | 96 07 30 | 4 26 | 11 15 | 16. 9 | 7. 0 |
| | Moulmein: Docks | 16 26 00 | 97 38 00 | 3 07 | 10 49 | 11. 7 | 5. 0 |
| | Moulmein River: Amherst Pt. light | 16 04 45 | 97 33 05 | 2 12 | 8 49 | 19. 2 | 7. 4 |
| | Double Island: Light-house | 15 52 00 | 97 35 00 | | | | |
| | Tavoy River: Light-house | 13 36 40 | 98 13 00 | 10 50 | 4 20 | 15. 6 | 5. 9 |
| | Mergui: Court-house | 12 26 15 | 98 35 59 | 10 40 | 4 10 | 18. 0 | 6. 9 |
| | Tenasserim | 12 06 00 | 99 03 00 | | | | |
| | St. Matthew Island: Hastings Harbor | 10 05 05 | 98 10 15 | | | | |
| | Pak Chan River: Light-house | 9 58 00 | 97 35 00 | | | | |
| **Malaysia.** | Tongka Harbor, Junkseylon Island: Light-house | 7 50 00 | 98 25 30 | | | | |
| | Pulo Penang: Fort Cornwallis | 5 24 45 | 100 21 44 | 11 50 | 5 40 | 8. 8 | 3. 8 |
| | Dinding Channel: Hospital Rock | 4 13 05 | 100 34 15 | | | | |
| | One Fathom Bank: Light-house | 2 52 10 | 100 59 12 | 5 50 | 12 00 | 14. 4 | 6. 2 |
| | Cape Rachado: Light-house | 2 24 08 | 101 51 02 | | | | |
| | Malacca; Stat. St. Pauls Hill | 2 11 30 | 102 15 00 | 7 20 | 1 08 | 10. 5 | 4. 5 |
| | Singapore Strait: Coney Island light | 1 09 57 | 103 44 47 | | | | |
| | Singapore: Fullerton Battery | 1 17 11 | 103 51 15 | 10 18 | 4 02 | 7. 6 | 3. 2 |
| | Singapore Strait: Pedra Branca light | 1 19 57 | 104 24 08 | | | | |
| | Summit Bintang great hill, 1,253 feet | 1 04 20 | 104 27 21 | | | | |
| | Rhio Straits, Pulo Sauh: Light-house | 1 03 13 | 104 10 30 | | | | |
| | Terkolei: Light-house | 0 57 10 | 104 19 52 | | | | |
| | Little Garras: Light-house | 0 44 30 | 104 21 19 | 9 40 | 3 14 | 7. 1 | 3. 1 |
| | Rhio, Bintang Island: Residency flagstaff | 0 55 50 | 104 25 43 | | | | |
| | Pitong Island: Peak | 0 36 52 | 104 04 42 | | | | |
| | Abang Besar Island: N. pt | 0 36 30 | 104 11 31 | | | | |
| | | Lat. S. | | | | | |
| | Linga Island: Flagstaff | 0 12 34 | 104 36 14 | 6 00 | 12 13 | 11. 5 | 4. 9 |
| | Singkep Island: Mountain summit | 0 26 13 | 104 30 15 | | | | |
| | Menali Island: N. pt | 0 57 51 | 105 38 20 | | | | |
| | | Lat. N. | | | | | |
| | Nicobar Islands, Car Nicobar: N. pt | 9 15 40 | 92 48 00 | | | | |

### MARITIME POSITIONS AND TIDAL DATA.

#### SOUTH COAST OF ASIA—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Malaysia. | Nicobar Islands, Nancowry Harbor: Naval Pt.......... | 8 02 10 | 93 29 42 | 9 05 | 2 52 | 8.3 | 2.8 |
| | Great Nicobar: W. pt. Galathea Bay.. | 6 46 20 | 93 49 20 | ........ | ........ | ...... | ...... |
| | Acheen (Acheh) Head: Pulo Bras light | 5 45 00 | 95 04 33 | ........ | ........ | ...... | ...... |
| | N. extreme.... | 5 34 40 | 95 19 00 | 10 00 | 3 44 | 5.2 | 2.3 |
| | Diamond Point: Light-house .......... | 5 15 58 | 97 30 11 | 11 50 | 5 34 | 8.7 | 3.7 |
| | | Lat. S. | | | | | |
| Sumatra. | Point Baru or Datu: Extreme ......... | 0 00 32 | 103 47 58 | ........ | ........ | ...... | ...... |
| | Point Bon or Djabon: Extreme........ | 1 00 55 | 104 21 30 | ........ | ........ | ...... | ...... |
| | Moeara-Kompehi: Fort .............. | 1 23 13 | 103 59 14 | ........ | ........ | ...... | ...... |
| | Djambi: Flagstaff of fort ............. | 1 35 33 | 103 36 41 | ........ | ........ | ...... | ...... |
| | Palembang: Residency flagstaff........ | 2 59 26 | 104 45 34 | ........ | ........ | ...... | ...... |
| | Lampong Bay: Telok Betong light..... | 5 27 00 | 105 15 58 | ........ | ........ | ...... | ...... |
| | Blimbing Bay ...................... | 5 55 02 | 104 32 36 | 5 40 | 11 52 | 2.6 | 0.7 |
| | Kroë: Village ...................... | 5 11 24 | 103 55 42 | ........ | ........ | ...... | ...... |
| | Engano Island: Barioe anchorage....... | 5 18 50 | 102 07 28 | ........ | ........ | ...... | ...... |
| | Bintœan: River mouth ............... | 4 48 35 | 103 20 18 | ........ | ........ | ...... | ...... |
| | Mega Island: N. pt ................. | 3 59 25 | 101 00 58 | ........ | ........ | ...... | ...... |
| | Benkulen: Light-house .............. | 3 47 22 | 102 14 50 | 5 50 | 12 03 | 4.0 | 1.1 |
| | Bantal: Village..................... | 2 44 54 | 101 17 25 | ........ | ........ | ...... | ...... |
| | Indrapura Point: Extreme ........... | 2 10 35 | 100 50 06 | ........ | ........ | ...... | ...... |
| | Pisang: Light-house ................ | 0 59 56 | 100 19 28 | ........ | ........ | ...... | ...... |
| | Padang: Light-house ................ | 0 57 53 | 100 20 19 | 5 35 | 11 48 | 5.5 | 1.4 |
| | Siberaet Island: Sigeb Pt........... | 0 53 58 | 98 53 58 | ........ | ........ | ...... | ...... |
| | Katiagam: Village.................. | 0 07 41 | 99 45 20 | ........ | ........ | ...... | ...... |
| | Batoe Islands: N. point of Simoe Islet.. | 0 03 13 | 98 05 55 | ........ | ........ | ...... | ...... |
| | Summit of Tello......... | 0 02 56 | 98 16 43 | ........ | ........ | ...... | ...... |
| | | Lat. N. | | | | | |
| | Ayer Bangis: Fort flagstaff ........... | 0 11 41 | 99 22 09 | 5 29 | 11 42 | 2.8 | 0.7 |
| | Natal: Fort flagstaff................ | 0 33 11 | 99 06 33 | ........ | ........ | ...... | ...... |
| | Nias Island: Lagoendi Bay .......... | 0 34 47 | 97 43 43 | ........ | ........ | ...... | ...... |
| | Sitoli.................... | 1 17 36 | 97 36 46 | ........ | ........ | ...... | ...... |
| | Lapan.................. | 1 24 16 | 97 12 28 | ........ | ........ | ...... | ...... |
| | Siboga: Flagstaff .................. | 1 44 24 | 98 46 08 | ........ | ........ | ...... | ...... |
| | Singkel: Post-office................ | 2 16 47 | 97 45 06 | ........ | ........ | ...... | ...... |
| | Bangkaru Islands: Bay .............. | 2 02 32 | 97 06 53 | ........ | ........ | ...... | ...... |
| | Simaloe Island: NW. pt............. | 2 51 30 | 95 56 02 | ........ | ........ | ...... | ...... |
| | Tampat Toewon; Flagstaff ........... | 3 14 59 | 97 10 13 | ........ | ........ | ...... | ...... |
| | Analaboe .......................... | 4 08 14 | 96 07 23 | ........ | ........ | ...... | ...... |
| | Batve Toetong: Landing place......... | 4 38 21 | 95 34 29 | ........ | ........ | ...... | ...... |

### EAST COAST OF ASIA.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | Lat. S. | | | | | |
| Banka Strait. | Java Head: First Pt. light ............. | 6 44 30 | 105 11 48 | 5 30 | 11 42 | 2.5 | 0.7 |
| | Sunda Strait: Krakatoa I. peak........ | 6 08 46 | 105 26 58 | 6 50 | 0 37 | 3.8 | 1.1 |
| | North Watcher Island: Light-house.... | 5 12 17 | 106 27 33 | ........ | ........ | ...... | ...... |
| | Lucipara I.: Beacon ................ | 3 13 05 | 106 13 02 | ........ | ........ | ...... | ...... |
| | Banka Island: Tobol Ali Fort ........ | 3 00 48 | 106 27 22 | [9 05] | [2 52] | [10.1] | ...... |
| | Berikat, summit......... | 2 34 18 | 106 50 36 | ........ | ........ | ...... | ...... |
| | Nanka I.: Light-house ............... | 2 23 20 | 105 44 30 | [6 50] | [0 38] | [9.3] | ...... |
| | Banka Island: Mintok light ........... | 2 04 03 | 105 09 45 | ........ | ........ | ...... | ...... |
| | Blinyu................... | 1 38 26 | 105 46 28 | ........ | ........ | ...... | ...... |
| | Crassok Pt.............. | 1 29 00 | 106 57 30 | ........ | ........ | ...... | ...... |
| Gaspar Strait. | Shoalwater Island: Light-house ........ | 3 19 10 | 107 12 42 | [2 08] | [8 21] | [5.6] | ...... |
| | Pulo Lepar: Light-house............... | 2 56 52 | 106 54 38 | ........ | ........ | ...... | ...... |
| | Pulo Jelaka: Light-house ............. | 2 52 05 | 107 00 43 | ........ | ........ | ...... | ...... |
| | Billiton Island: Tandjong Pandan flag-staff.................... | 2 44 40 | 107 38 46 | ........ | ........ | ...... | ...... |
| | Langkuas I. light....... | 2 32 12 | 107 37 15 | [3 17] | [9 29] | [6.6] | ...... |
| | Gaspar Island: Peak.................. | 2 24 30 | 107 03 33 | ........ | ........ | ...... | ...... |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Entrance China Sea.** | Carimata Island: Sharp peak | 1 33 24 | 108 55 13 | ........ | ........ | ........ | ........ |
| | Pulo Eu: Center | 2 07 00 | 104 17 00 | ........ | ........ | ........ | ........ |
| | Pulo Aor: S. peak, 1,805 feet | 2 26 30 | 104 34 06 | ........ | ........ | ........ | ........ |
| | | Lat. N. | | | | | |
| | St. Barbe Island: Center of W. side | 0 07 26 | 107 13 00 | ........ | ........ | ........ | ........ |
| | Direction Island: S. pt | 0 14 19 | 108 01 47 | ........ | ........ | ........ | ........ |
| | Dato Island: Summit | 0 06 37 | 108 37 05 | ........ | ........ | ........ | ........ |
| | St. Julian Island: Summit | 0 55 00 | 106 45 00 | ........ | ........ | ........ | ........ |
| | Tambelan Island: S. pt | 0 56 52 | 107 32 57 | ........ | ........ | ........ | ........ |
| | Tamban I. obs. station | 1 00 27 | 106 24 10 | ........ | ........ | ........ | ........ |
| | Victory Island: S. pt | 1 34 41 | 106 18 27 | ........ | ........ | ........ | ........ |
| | Anamba Islands: White rock | 2 18 10 | 105 35 58 | ........ | ........ | ........ | ........ |
| | Pulo Repon | 2 25 00 | 105 52 00 | ........ | ........ | ........ | ........ |
| | Pulo Domar | 2 44 31 | 105 22 57 | ........ | ........ | ........ | ........ |
| | St. Pierre Rock: S. pt | 1 51 42 | 108 38 55 | ........ | ........ | ........ | ........ |
| | Natuna Islands: Pyramidal rocks | 4 03 00 | 107 21 40 | ........ | ........ | ........ | ........ |
| | Semione I | 4 31 00 | 107 42 30 | ........ | ........ | ........ | ........ |
| **Gulf of Siam.** | Pulo Varella: Center | 3 17 00 | 103 40 00 | ........ | ........ | ........ | ........ |
| | Pulo Brala: Center | 4 53 00 | 103 38 00 | ........ | ........ | ........ | ........ |
| | Tringano River: N. pt | 5 21 40 | 103 08 00 | 8 00 | 1 48 | 5.8 | 2.5 |
| | Great Redang Harbor: Bukit Maria I | 5 44 21 | 103 01 37 | ........ | ........ | ........ | ........ |
| | Kalantan: Entrance small river | 6 11 53 | 102 20 47 | ........ | ........ | ........ | ........ |
| | Cape Patani: NE. pt | 6 58 01 | 101 18 39 | ........ | ........ | ........ | ........ |
| | Singora: SW. pt. of Ticos I | 7 13 54 | 100 36 12 | 8 20 | 2 08 | 2.8 | 1.2 |
| | Koh Krah Islet: SE. pt | 8 24 47 | 100 45 27 | ........ | ........ | ........ | ........ |
| | Bangkok: Old British factory | 13 44 20 | 100 28 42 | 8 00 | 2 00 | 7.3 | 3.1 |
| | Cape Liant: NW. rock of Koh Mesan | 12 35 08 | 100 56 47 | ........ | ........ | ........ | ........ |
| **Cochin China.** | Chentabun River: Entrance, Bar I | 12 27 43 | 102 04 19 | 10 00 | 3 50 | 4.5 | 2.1 |
| | Koh Chang: Small island on W. side | 12 01 20 | 102 15 47 | ........ | ........ | ........ | ........ |
| | Koh Kong: S. pt. of river entrance | 11 33 00 | 102 57 14 | ........ | ........ | ........ | ........ |
| | Kusrovie Rock: Center | 11 06 25 | 102 47 49 | ........ | ........ | ........ | ........ |
| | Koh Tang Rocks: SW. rock of group | 10 21 20 | 102 56 34 | ........ | ........ | ........ | ........ |
| | Panjang Island: NW. corner of SW. bay | 9 18 14 | 103 29 14 | ........ | ........ | ........ | ........ |
| | Obi Islands: Light-house | 8 25 20 | 104 48 30 | ........ | ........ | ........ | ........ |
| | Saigon: Observatory | 10 46 47 | 106 42 10 | 5 00 | 11 20 | 9.8 | 4.2 |
| | Mitho: S. gate of citadel | 10 21 16 | 106 20 38 | ........ | ........ | ........ | ........ |
| | Cape St. James: Light-house | 10 19 51 | 107 04 55 | ........ | ........ | ........ | ........ |
| | Cape Padaran: Extreme | 11 21 00 | 108 58 00 | ........ | ........ | ........ | ........ |
| | Cape Varella: Extreme | 12 53 40 | 109 23 42 | ........ | ........ | ........ | ........ |
| | Quin Hon: Battery flagstaff | 13 45 23 | 109 14 52 | ........ | ........ | ........ | ........ |
| **China Sea.** | Condore Islands: Light-house | 8 40 06 | 106 41 42 | ........ | ........ | ........ | ........ |
| | Safatu Island: Summit | 9 58 23 | 109 06 00 | ........ | ........ | ........ | ........ |
| | Ceicer de Mer Island: SW. hill | 10 32 36 | 108 56 27 | ........ | ........ | ........ | ........ |
| | Natuna Islands: Murundum I., SE. pt | 2 02 55 | 109 06 10 | ........ | ........ | ........ | ........ |
| | Low I | 3 00 00 | 107 48 00 | ........ | ........ | ........ | ........ |
| **Cochin China.** | Canton Pulo: Light-house | 15 23 34 | 109 05 35 | ........ | ........ | ........ | ........ |
| | Cham-Callao Islet: Watering place | 15 57 10 | 108 32 47 | ........ | ........ | ........ | ........ |
| | Tourane Bay: Light-house | 16 07 00 | 108 11 30 | ........ | ........ | ........ | ........ |
| | Hon-Mé: Summit | 19 22 14 | 105 55 22 | ........ | ........ | ........ | ........ |
| | Nam-Dinh: Citadel tower | 20 25 30 | 106 08 41 | ........ | ........ | ........ | ........ |
| | Hon Dau Island: Light-house | 20 40 03 | 106 47 10 | 9 00 | 2 48 | 4.3 | 2.1 |
| **China.** | Hai-Fong: Observation pagoda | 20 51 44 | 106 41 08 | ........ | ........ | ........ | ........ |
| | Hai-Duong: Citadel tower | 20 56 29 | 106 17 56 | ........ | ........ | ........ | ........ |
| | Ha-Noi: Citadel tower | 21 01 57 | 105 48 40 | ........ | ........ | ........ | ........ |
| | Pak-Hoi: Custom-house flagstaff | 21 29 00 | 109 06 00 | 5 00 | 11 12 | 14.0 | 6.6 |
| | Hainan Island: Cape Bastion, extreme | 18 09 00 | 109 35 00 | ........ | ........ | ........ | ........ |
| | Gaalong Bay, E. Brother | 18 11 30 | 109 41 30 | ........ | ........ | ........ | ........ |

MARITIME POSITIONS AND TIDAL DATA.

**EAST COAST OF ASIA—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Hainan Island: Light-house | 20 01 15 | 110 16 10 | | | | |
| | Paracel Islands: Triton I | 15 46 30 | 111 14 30 | | | | |
| | Observation bank | 16 36 00 | 111 40 30 | | | | |
| | Lincoln I | 16 40 07 | 112 43 32 | | | | |
| | Woody I | 16 49 55 | 112 20 44 | | | | |
| | Pratas Island: NE. part | 20 42 03 | 116 43 07 | | | | |
| | Ty-fung-kyoh Island: Center | 21 22 30 | 111 10 30 | | | | |
| | Tien-pak Harbor: Pauk Pyah Islet | 21 24 15 | 111 15 25 | 11 50 | 5 37 | 8.2 | 3.8 |
| | Song-yui Point: Extreme | 21 31 00 | 111 38 30 | | | | |
| | Hui-lang-san Harbor: Mamechow Islet | 21 34 00 | 111 46 43 | | | | |
| | Mandarins Cap: Summit, 200 ft | 21 28 00 | 112 21 30 | | | | |
| | Macao: Fort Guia light | 22 11 40 | 113 34 00 | 9 50 | 3 38 | 6.3 | 3.0 |
| | Fort San Francisco | 22 11 24 | 113 33 25 | | | | |
| | Canton: Dutch Folly light | 23 06 35 | 113 16 30 | 2 00 | 8 00 | 5.1 | 2.4 |
| | Raleigh Rock: Center | 22 02 00 | 113 47 00 | | | | |
| | Gap Rock: Light-house | 21 48 50 | 113 56 20 | | | | |
| | Hongkong: Cathedral | 22 16 52 | 114 09 31 | | | | |
| | Wellington Battery | 22 16 23 | 114 10 02 | 9 20 | 2 52 | 4.4 | 2.0 |
| | Lema Island: Lema Head | 22 03 40 | 114 19 25 | | | | |
| | Nine-pin Rock: Center | 22 15 45 | 114 22 07 | | | | |
| | Tuni-ang Island: Summit | 22 27 06 | 114 36 45 | | | | |
| | Single Island: E. summit | 22 24 06 | 114 39 12 | | | | |
| | Mendoza Island: Summit | 22 30 42 | 114 50 00 | | | | |
| | Pank Piah Rock: Summit | 22 32 54 | 115 01 00 | | | | |
| | Pedra Blanca Rock: Summit, 130 ft | 22 18 30 | 115 06 54 | | | | |
| | Chino Bay: Obs. spot | 22 48 14 | 115 47 56 | | | | |
| | Cupchi Point: Hill | 22 48 07 | 116 04 26 | | | | |
| | Breaker Point: Light-house | 22 56 24 | 116 29 44 | | | | |
| | Cape of Good Hope: Light-house | 23 14 00 | 116 47 00 | | | | |
| | Swatau: British consulate | 23 20 43 | 116 40 22 | 2 50 | 9 00 | 7.5 | 3.5 |
| | Lamock Island: Light-house | 23 15 43 | 117 17 04 | | | | |
| | Brothers Islets: SE. Islet | 23 32 30 | 117 42 00 | | | | |
| China. | Tong-sang Harbor: Fall Peak | 23 47 15 | 117 36 48 | 11 20 | 5 08 | 12.0 | 7.6 |
| | Chapel Island: Light-house | 24 09 49 | 118 13 30 | | | | |
| | Amoy: Taitan I. light | 24 23 16 | 118 10 00 | 0 05 | 6 13 | 15.5 | 9.9 |
| | Dodd Island: Light-house | 24 25 44 | 118 30 11 | | | | |
| | Chinchin Harbor: Pisai Islet | 24 49 13 | 118 41 00 | | | | |
| | Pyramid Point: Extreme | 24 52 12 | 118 58 00 | | | | |
| | Ockseu Island: Light-house | 24 59 36 | 119 27 07 | | | | |
| | Sorrel Rock: Summit | 25 02 18 | 119 10 36 | | | | |
| | Lamyit Island: High Cone Peak | 25 12 00 | 119 35 00 | | | | |
| | Hungwha Channel: Sentry I | 25 16 30 | 119 45 00 | | | | |
| | Turnabout Island: Light-house | 25 26 10 | 119 56 07 | | | | |
| | East Dog Island: Light-house | 25 58 10 | 119 59 02 | | | | |
| | Min River: Pagoda, Losing I | 25 59 00 | 119 27 16 | 0 30 | 7 00 | 19.3 | 12.2 |
| | Temple Pt | 26 08 26 | 119 37 35 | 9 45 | 3 33 | 19.0 | 12.0 |
| | Alligator Island: Summit | 26 09 29 | 120 24 06 | | | | |
| | Tung-yung Islands: Peak, N. end | 26 22 37 | 120 29 40 | | | | |
| | Coney Island: Summit | 26 30 00 | 120 10 00 | | | | |
| | Double Peak Island: Highest peak | 26 36 06 | 120 11 12 | | | | |
| | Pih-seang Island: Town I | 26 42 30 | 120 22 42 | | | | |
| | Dangerous Rock: Summit | 26 51 25 | 120 32 33 | | | | |
| | Tae Islands: Summit | 26 58 52 | 120 42 34 | | | | |
| | Nam-quan Harbor: Bate I | 27 09 20 | 120 25 50 | 9 50 | 3 38 | 17.2 | 10.9 |
| | Ping-fong Island: Summit | 27 09 42 | 120 32 42 | | | | |
| | Pih-quan Peak: Summit | 27 19 18 | 120 27 14 | | | | |
| | Port Namki: E. horn | 27 26 18 | 121 06 36 | | | | |
| | Pih-ki-shan Island: Summit | 27 37 36 | 121 12 09 | | | | |
| | Pe-shan Islands: Summit, SW. end | 28 05 07 | 121 30 04 | | | | |
| | Tung-chuh Island: Summit | 28 43 45 | 121 55 21 | | | | |
| | Kweshan Islands: Patahecock | 29 22 45 | 122 13 16 | | | | |
| | Nimrod Sound: Middle islet | 29 34 20 | 121 43 15 | | | | |
| | Tong-ting Islet: Summit | 29 51 53 | 122 35 24 | | | | |
| | Chin-hai: Citadel | 29 57 08 | 121 43 06 | | | | |
| | Ning-po: Square I. light | 29 59 21 | 121 45 22 | 1 00 | 7 12 | 8.8 | 4.6 |
| | Chusan Islands: Ting-hai Harbor | 30 04 30 | 122 03 47 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| China. | Video Island: Summit .............. | 30 08 04 | 122 45 48 | ........ | ........ | ...... | ...... |
| | West Volcano Island: Light-house ..... | 30 20 50 | 121 51 25 | ........ | ........ | ...... | ...... |
| | Chapu: Battery ...................... | 30 36 00 | 121 03 00 | ........ | ........ | ...... | ...... |
| | Gutzlaff Island: Light-house ........... | 30 48 37 | 122 10 12 | ........ | ........ | ...... | ...... |
| | Saddle Islands: N. Saddle light........ | 30 51 41 | 122 40 17 | ........ | ........ | ...... | ...... |
| | West Barren Island: Summit........... | 30 44 07 | 123 08 27 | ........ | ........ | ...... | ...... |
| | Shanghai: Eng. consulate flagstaff ..... | 31 14 42 | 121 28 55 | ........ | ........ | ...... | ...... |
| | Wusung: Light-house ................. | 31 23 18 | 121 29 36 | 0 12 | 8 06 | 9.1 | 4.8 |
| | Shaweishan Island: Light-house........ | 31 25 27 | 122 14 12 | ........ | ........ | ...... | ...... |
| | Pescadores Islands: Fisher I. light ..... | 23 32 53 | 119 28 05 | ........ | ........ | ...... | ...... |
| | Second pt. on N. side Makung Harbor.. | 23 32 54 | 119 30 12 | ........ | ........ | ...... | ...... |
| Formosa I. | South Cape: Light-house............... | 21 55 00 | 120 51 00 | ........ | ........ | ...... | ...... |
| | Takau: Saracen Head ................. | 22 36 14 | 120 15 54 | 9 45 | 3 32 | 4.0 | 1.7 |
| | Port Heongsan ....................... | 24 46 00 | 120 55 00 | ........ | ........ | ...... | ...... |
| | Tam-sui Harbor: White Fort........... | 25 10 24 | 121 25 00 | 10 00 | 3 47 | 8.0 | 3.4 |
| | Kelung Harbor: Light-house ........... | 25 09 12 | 121 44 28 | 10 15 | 4 03 | 3.0 | 1.3 |
| | Soo (Sauo) Bay: Beach near village.... | 24 35 28 | 121 49 20 | 6 00 | 12 13 | 5.8 | 2.5 |
| | Botel Tobago Sima: S. extreme........ | 22 01 40 | 121 39 45 | ........ | ........ | ...... | ...... |
| Borneo. | Tanjong Datu ........................ | 2 05 15 | 109 39 07 | ........ | ........ | ...... | ...... |
| | Saráwak River: Po Pt. light........... | 1 43 50 | 110 30 30 | 4 00 | 10 12 | 9.0 | 3.9 |
| | Saráwak: Fort ....................... | 1 33 55 | 109 20 40 | 5 20 | 11 35 | 14.1 | 6.1 |
| | Cape Sirik: Light-house............... | 2 45 20 | 111 21 20 | — | ........ | ...... | ...... |
| | Tanjong Barram ...................... | 2 36 15 | 113 58 57 | ........ | ........ | ...... | ...... |
| | Bruni River: Light-house ............. | 5 02 00 | 115 03 00 | ........ | ........ | ...... | ...... |
| | Labuan I., Victoria Hbr.: Light-house.. | 5 15 25 | 115 16 05 | 9 35 | 3 23 | 5.5 | 2.4 |
| | Sandakhan Harbor: Light-house ....... | 5 50 10 | 118 07 20 | 12 00 | 5 50 | 5.2 | 2.2 |
| | Unsang: Anchorage ................... | 5 16 30 | 119 16 00 | ........ | ........ | ...... | ...... |
| | Cape Kaniongan: E. pt. of Borneo..... | 1 04 00 | 118 56 00 | ........ | ........ | ...... | ...... |
| | | Lat. S. | | | | | |
| | Pamaroong I.: E. pt. delta River Koetei.. | 0 45 00 | 117 37 00 | [7 45] | [1 33] | [7.0] | ...... |
| | Pulo Laut: S. pt. Koengit Islet ....... | 4 05 42 | 116 01 40 | ........ | ........ | ...... | ...... |
| | Selatan Point: Extreme of Sita Pt ..... | 4 10 40 | 114 42 18 | ........ | ........ | ...... | ...... |
| | Bandjermasin: Residency flagstaff ..... | 3 18 55 | 114 34 56 | ........ | ........ | ...... | ...... |
| | Sampit Bay: Bandaran Pt............. | 3 16 00 | 113 08 00 | ........ | ........ | ...... | ...... |
| | Kottaringin Bay: Samadra I .......... | 2 54 00 | 111 24 00 | ........ | ........ | ...... | ...... |
| | Succadana: Town ..................... | 1 14 00 | 109 58 00 | ........ | ........ | ...... | ...... |
| | Padang Tikar: Point.................. | 0 40 00 | 109 16 00 | 7 00 | 0 47 | 7.2 | 3.1 |
| Celebes Island. | Port Laykan: SW. pt. of Celebes ...... | 5 36 00 | 119 26 00 | ........ | ........ | ...... | ...... |
| | Macassar: Fort light .................. | 5 08 09 | 119 23 55 | 4 40 | 10 55 | 3.9 | 2.9 |
| | Palos Bay: Village at head ........... | 0 57 00 | 119 47 30 | ........ | ........ | ...... | ...... |
| | | Lat. N. | | | | | |
| | Cape Rivers: NE. Cape, Slime Islet.... | 1 20 00 | 120 43 30 | ........ | ........ | ...... | ...... |
| | Gorontalo: Light-house ............... | 0 29 41 | 123 03 08 | ........ | ........ | ...... | ...... |
| | Manado Bay: Light-house.............. | 1 31 00 | 124 50 00 | 6 00 | 12 15 | 4.3 | 3.1 |
| | Bajuren Island: Summit .............. | 2 07 00 | 125 22 00 | ........ | ........ | ...... | ...... |
| | Tagulanda Island: Peak.............. | 2 22 00 | 125 24 30 | ........ | ........ | ...... | ...... |
| | Seao Island: Conical peak............ | 2 44 00 | 125 26 00 | ........ | ........ | ...... | ...... |
| | Sauguir Island: S. pt. Cape Palumbatu.. | 3 21 00 | 125 39 00 | ........ | ........ | ...... | ...... |
| | Taluat Island: Kabruang I., SE. pt.... | 3 49 00 | 127 02 30 | ........ | ........ | ...... | ...... |
| | Cape Flesko: Extreme ................ | 0 27 00 | 124 26 00 | ........ | ........ | ...... | ...... |
| | | Lat. S. | | | | | |
| | Cape Talabo: E. end.................. | 0 46 00 | 123 27 00 | ........ | ........ | ...... | ...... |
| | Wowoni Island: N. pt ................ | 3 58 00 | 123 00 00 | ........ | ........ | ...... | ...... |
| | Bouton Island: N. pt ................ | 4 23 30 | 123 04 00 | ........ | ........ | ...... | ...... |
| | E. pt ................ | 5 15 00 | 123 16 00 | ........ | ........ | ...... | ...... |
| | Fort ................ | 5 29 15 | 122 36 41 | ........ | ........ | ...... | ...... |
| | Cape Lassa: Extreme ................. | 5 35 00 | 120 29 00 | ........ | ........ | ...... | ...... |
| | Salayar Island: N. pt ................ | 5 47 00 | 120 30 00 | ........ | ........ | ...... | ...... |
| | S. pt ................ | 6 26 00 | 120 28 30 | ........ | ........ | ...... | ...... |

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Java.** | Anjer: Fourth pt. light | 6 04 15 | 105 53 05 | 7 11 | 0 58 | 2.4 | 0.7 |
| | Bantam: Flagstaff | 6 01 20 | 106 08 20 | | | | |
| | Batavia: Observatory | 6 07 40 | 106 48 37 | [11 58] | [5 46] | [3.0] | |
| | Buitenzorg: Palace tower | 6 35 45 | 106 49 11 | | | | |
| | Boompjeo Island: Racket I. light | 5 56 15 | 108 22 37 | | | | |
| | Cheribon: Light-house | 6 43 00 | 108 34 00 | | | | |
| | Tegal: Flagstaff | 6 51 09 | 109 08 07 | | | | |
| | Pekalongan: Light W. of entrance | 6 51 29 | 109 41 08 | | | | |
| | Samarang: Light-house | 6 57 09 | 110 25 03 | [6 00] | [12 13] | [4.0] | |
| | Rembang: Residency flagstaff | 6 42 18 | 111 20 32 | | | | |
| | Surabaya: Time-ball station | 7 12 10 | 112 43 58 | 12 07 | 5 54 | 4.9 | 1.7 |
| | Pasuruan: Light-house | 7 37 30 | 112 55 00 | 11 44 | 5 31 | 6.2 | 2.3 |
| | Madura Island: Light-house | 7 02 00 | 112 41 09 | | | | |
| | Soemenep flagstaff | 7 02 30 | 113 53 45 | | | | |
| | Besuki: Light-house | 7 43 25 | 113 41 10 | | | | |
| | Cape Sedano: NE. pt. of Java | 7 49 00 | 114 26 53 | | | | |
| | Banjuwangi: Fort | 8 12 30 | 114 22 55 | 10 00 | 3 45 | 7.8 | 2.6 |
| | Bantenan: S. pt. of Java | 8 47 00 | 114 25 13 | | | | |
| | Barung Island: S. pt | 8 32 00 | 113 15 00 | | | | |
| | Kambangan Island: Light-house | 7 46 30 | 109 02 12 | 8 33 | 2 21 | 5.2 | 1.8 |
| | Cape Anjoe: Extreme | 7 25 00 | 106 24 30 | | | | |
| **Islands.** | Karimon Djawa Island: Flagstaff | 5 52 57 | 110 25 29 | | | | |
| | Rawean Island: Sangkapura flagstaff | 5 51 18 | 112 39 10 | | | | |
| | Great Solombo Island: NW. pt | 5 32 28 | 114 23 42 | | | | |
| | Arentes Island: S. pt | 5 05 46 | 114 35 00 | | | | |
| | Bali Island: Bliling light-house | 8 05 30 | 115 03 48 | | | | |
| | Peak, 11,326 ft | 8 21 00 | 115 28 00 | | | | |
| | Badong Bay, Kotta village | 8 42 30 | 115 08 47 | 10 50 | 4 38 | 8.7 | 3.0 |
| | Lombok Island: Peak 12,379 ft | 8 23 00 | 116 27 30 | | | | |
| | Ampenam light | 8 34 15 | 116 04 09 | 7 50 | 1 37 | 5.8 | 2.0 |
| | Sumbawa I.: Sumbawa village | 8 32 00 | 117 20 33 | | | | |
| | Tambora Volcano, summit E. side of crater | 8 12 30 | 117 57 00 | | | | |
| | Bima, flagstaff | 8 27 00 | 118 43 55 | 0 00 | 6 12 | 5.7 | 2.0 |
| | Postilion Islands: N. island | 6 31 00 | 118 43 00 | | | | |
| | Maria Reigersbergen I | 7 30 00 | 117 56 00 | | | | |
| | Ardassier Islands: S. id | 7 35 00 | 117 22 00 | | | | |
| | Brill Reef: Light-house | 6 05 50 | 118 56 50 | | | | |
| | Hegadis Island | 6 07 00 | 122 40 00 | | | | |
| | Token Bessi I.: Wangi-Wingi, NW. pt. | 5 15 00 | 123 32 00 | | | | |
| | Binongko, S. pt | 6 17 00 | 123 59 00 | | | | |
| | Gunong Api: Volcano | 6 43 00 | 126 43 30 | | | | |
| | Lucipari Islands: N. islet | 5 28 30 | 127 30 00 | | | | |
| | Flores Island: Reo village | 8 16 15 | 120 29 55 | | | | |
| | Ende village | 8 50 55 | 121 38 40 | | | | |
| | Flores Head, extreme | 8 04 45 | 122 52 00 | | | | |
| | Komba Island: Peak, S. part | 7 48 00 | 123 31 00 | | | | |
| | Adenara Island: Summit, Mount Woka. | 8 20 30 | 123 15 00 | | | | |
| | Lombata Island: Mount Lamararap | 8 33 00 | 123 22 00 | | | | |
| | Pantar Island: S. peak of saddle on S. pt | 8 34 00 | 124 06 00 | | | | |
| | Ornbay Island: Dololo anchorage | 8 12 00 | 124 23 00 | | | | |
| | Timor Island: Deli, custom-house | 8 34 00 | 125 33 57 | 0 45 | 6 58 | 5.7 | 2.0 |
| | Atapopa | 9 00 00 | 124 52 00 | | | | |
| | Koupang, Fort Concordia | 10 09 54 | 123 33 57 | 10 50 | 4 37 | 8.5 | 2.9 |
| | Rotti Island: W. pt | 10 46 00 | 122 52 00 | | | | |
| | Saru Island: Seba Bay, on NW. side | 10 29 00 | 121 46 00 | | | | |
| | Sandalwood Island: Nangamessie | 9 35 03 | 120 14 30 | 11 20 | 5 07 | 16.5 | 5.6 |
| | Wetta Island: Ilwaki road | 7 53 00 | 126 22 00 | | | | |
| | Roma Island: W. pt | 7 38 00 | 127 19 00 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Moa Island: Buffalo Peak, 4,100 ft..... | 8 12 00 | 128 01 00 | | | | |
| | Sermalta Islands: NE. pt ............... | 8 14 00 | 129 00 00 | | | | |
| | Damma Island: Kulewatta Harbor, N. pt. | 7 03 00 | 128 28 00 | | | | |
| | Nila Island: Center.................... | 6 44 00 | 129 29 00 | | | | |
| | Mano or Bird Island: NW. extremity.. | 5 32 50 | 130 17 44 | | | | |
| | Timor Laut Island: Olilet, on E. coast.. | 7 55 00 | 131 23 30 | | | | |
| | Vordate Island: S. pt.................. | 7 04 00 | 131 55 00 | | | | |
| | Mulu Island: N. pt.................... | 6 35 00 | 131 40 00 | | | | |
| | Arru Islands: S. island ............... | 7 10 00 | 134 24 00 | | | | |
| | N. pt.................... | 5 20 00 | 134 40 00 | | | | |
| | Great Ki Island: S. pt ................ | 5 56 00 | 132 54 00 | | | | |
| | Tello Islands: S. island, summit ....... | 5 20 00 | 131 58 00 | | | | |
| | Tehor Island: NE. pt.................. | 4 44 00 | 131 47 00 | | | | |
| | Matabella Islands: Kukur............. | 4 33 00 | 131 50 00 | | | | |
| | Goram Islands: Goram Mosque ........ | 4 03 05 | 131 25 23 | | | | |
| | Banda Island: Mole ................... | 4 31 53 | 129 53 18 | 1 45 | 7 57 | 9.0 | 6.6 |
| | Bouro Island, Kajeli: Fort Defense .... | 3 22 48 | 127 06 18 | 1 20 | 7 32 | 4.2 | 3.1 |
| | Ceram Island: Kawa .................. | 2 55 52 | 128 07 04 | | | | |
| | Amboina Island: Light-house ......... | 3 41 00 | 128 10 00 | 2 20 | 8 32 | 7.5 | 5.5 |
| | Xulla Islands, Taliabo Island: NW. pt.. | 1 44 00 | 122 20 00 | | | | |
| | Mangola Island: E. pt .. | 1 48 12 | 126 21 19 | | | | |
| | Besi Island: E. pt....... | 2 28 00 | 126 01 00 | | | | |
| | Oby Major Island: W. pt .............. | 1 30 00 | 127 18 00 | | | | |
| | Popa Island: Outer Extremity Bay .... | 1 11 21 | 129 55 48 | | | | |
| | Mysole Island: Efbe Harbor .......... | 2 04 00 | 130 12 00 | | | | |
| Islands. | | Lat. N. | | | | | |
| | Gebey Islands: NW. pt................ | 0 02 02 | 129 17 30 | | | | |
| | Gillolo Island: Cape Tabo: E. extreme. | 0 11 00 | 128 52 00 | | | | |
| | Cape Salawag: NE. pt .. | 1 26 00 | 128 37 00 | | | | |
| | Derrick Point: N. extreme ............... | 2 12 00 | 128 03 30 | | | | |
| | Molucca Is., Makkian I.: Fort Reeburgh. | 0 24 00 | 127 21 00 | | | | |
| | Ternate Island: Residency flagstaff.................. | 0 47 13 | 127 22 39 | 5 00 | 11 10 | 3.9 | 2.9 |
| | | Lat. S. | | | | | |
| | Batian Island: Church .... | 0 38 03 | 127 28 21 | | | | |
| | | Lat. N. | | | | | |
| | Meiaco-Sima Is., Kumi I: N. Beach ... | 24 26 00 | 122 56 00 | | | | |
| | Broughton Bay: Landing place .......... | 24 21 30 | 124 17 40 | | | | |
| | Port Haddington: Hamilton pt ....... | 24 25 00 | 124 06 40 | | | | |
| | Tai-pin-san: Hirara, Karimata Anch .... | 24 48 18 | 125 17 57 | 7 27 | 1 14 | 4.9 | 2.1 |
| | Raleigh Rock: Summit, 270 ft........ | 25 55 00 | 124 35 00 | | | | |
| | Ti-ao-usu Island: Summit, 600 ft....... | 25 58 30 | 123 40 00 | | | | |
| | Hoa-pin-su Island: N. face ............ | 25 47 07 | 123 30 31 | | | | |
| | Loo Choo Islands, Great Loo Choo: Nafa-Kiang..... | 26 12 25 | 127 40 10 | 6 30 | 0 15 | 5.8 | 2.5 |
| | Yori-sima, 413 ft.. | 27 02 00 | 128 25 24 | | | | |
| | Yerabu-sima peak, 687 ft .......... | 27 21 00 | 128 33 10 | | | | |
| | Kakirouma: Summit, 2,207 ft .... | 27 44 00 | 128 59 00 | | | | |
| | Iwo-sima: Volcano, 541 ft........ | 27 53 00 | 128 14 30 | | | | |
| | Oho-sima: N. extreme ........... | 28 31 40 | 129 42 30 | | | | |
| | Kikai-jima: Summit, 867 ft...... | 28 18 00 | 129 59 00 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

**EAST COAST OF ASIA**—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Philippine Islands. | Balábac Island, Cape Melville: Light-house | 7 49 25 | 117 00 00 | ........ | ........ | ...... | ...... |
| | Paláwan Island, Cape Bovliluyan: S. extreme | 8 20 25 | 117 09 35 | ........ | ........ | ...... | ...... |
| | Victoria Peak, 5,680 ft. | 9 22 30 | 118 17 30 | ........ | ........ | ...... | ...... |
| | Port Royalist: Tide Pole Pt. Light | 9 43 43 | 118 43 03 | [11 30] | [5 20] | [6.5] | ...... |
| | Taytay Fort | 10 50 00 | 119 31 10 | ........ | ........ | ...... | ...... |
| | Port Barton: Bubon Pt. | 10 29 19 | 119 05 36 | ........ | ........ | ...... | ...... |
| | Kabuli I.: Summit, N. extreme | 11 26 25 | 119 29 55 | ........ | ........ | ...... | ...... |
| | Cuyo Island: Obs. spot | 10 51 26 | 121 00 25 | ........ | ........ | ...... | ...... |
| | Agutaya Islet: Summit of Mt. Aguade | 11 09 09 | 120 56 26 | ........ | ........ | ...... | ...... |
| | Quiniluban Islet: Summit | 11 25 47 | 120 45 38 | ........ | ........ | ...... | ...... |
| | Culion Island: Fort | 11 53 53 | 120 00 48 | ........ | ........ | ...... | ...... |
| | Busuanga Island: Mt. Tundalara | 12 02 09 | 120 12 56 | ........ | ........ | ...... | ...... |
| | Apo Islet: Summit | 12 39 46 | 120 27 18 | ........ | ........ | ...... | ...... |
| | Caluya Island: Summit | 11 54 28 | 121 30 24 | ........ | ........ | ...... | ...... |
| | Semerara Island: N. extremity | 12 06 45 | 121 20 10 | ........ | ........ | ...... | ...... |
| | Mindoro Island: Mangarin Pt., SE. extremity | 12 20 03 | 121 03 33 | ........ | ........ | ...... | ...... |
| | Sablayan Pt., Vantay | 12 50 15 | 120 44 42 | ........ | ........ | ...... | ...... |
| | Monte Calavite | 13 28 40 | 120 22 33 | ........ | ........ | ...... | ...... |
| | Escarceo Pt | 13 31 35 | 120 59 17 | ........ | ........ | ...... | ...... |
| | Pt. Dumaly | 13 06 05 | 121 29 20 | ........ | ........ | ...... | ...... |
| | Ylin Island | 12 17 15 | 121 01 53 | ........ | ........ | ...... | ...... |
| | Lubang Island, Port Tulig | 13 49 30 | 120 09 58 | ........ | ........ | ...... | ...... |
| | Luzon Island, Batangas: Ast. station | 13 45 22 | 121 02 56 | ........ | ........ | ...... | ...... |
| | Balayan: Plaza Rizal | 13 56 17 | 120 43 37 | [11 07] | [4 50] | [4.9] | ...... |
| | Loro Peak: Summit, 3,985 feet | 14 12 20 | 120 38 10 | ........ | ........ | ...... | ...... |
| | Caballo I.: Light-house | 14 21 48 | 120 36 40 | ........ | ........ | ...... | ...... |
| | Corregidor Island: Light-house | 14 22 27 | 120 33 48 | [10 22] | [3 56] | [4.4] | ...... |
| | Cavite: Sangley Pt. light | 14 29 50 | 120 54 40 | ........ | ........ | ...... | ...... |
| | Manila: Pasig light-house | 14 35 49 | 120 57 19 | 10 44 | [4 10] | [4.6] | ...... |
| | Manila: Cathedral | 14 35 31 | 120 58 06 | ........ | ........ | ...... | ...... |
| | Subig: Town | 14 52 36 | 120 13 52 | [9 42] | [4 33] | [3.8] | ...... |
| | Capones Islet: Light-house | 14 55 33 | 120 00 15 | ........ | ........ | ...... | ...... |
| | Iba: Ast. station | 15 19 30 | 119 57 11 | ........ | ........ | ...... | ...... |
| | Port Masinloc: Bani Pt. | 15 34 48 | 119 54 16 | ........ | ........ | ...... | ...... |
| | Santa Cruz: Plaza | 15 45 43 | 119 54 00 | ........ | ........ | ...... | ...... |
| | Sual: Army Hospital | 16 04 06 | 120 06 01 | [10 20] | [3 33] | [2.4] | ...... |
| | Silaqui Islet: Summit | 16 27 15 | 119 56 10 | [10 21] | [3 44] | [2.3] | ...... |
| | Port San Fernando: Main street | 16 37 15 | 120 18 25 | [9 40] | [3 29] | [2.6] | ...... |
| | Candon: Ast. station | 17 11 43 | 120 26 14 | ........ | ........ | ...... | ...... |
| | Port Santiago: Remark-able tree S. of port | 17 16 55 | 120 25 07 | ........ | ........ | ...... | ...... |
| | Vigan: Race track | 17 33 56 | 120 22 51 | ........ | ........ | ...... | ...... |
| | Salomague Island: Port Salomague flagstaff | 17 47 17 | 120 25 04 | ........ | ........ | ...... | ...... |
| | Currimao: Town | 18 01 09 | 120 28 44 | ........ | ........ | ...... | ...... |
| | Capa Bojeador: Light-house | 18 31 08 | 120 35 35 | ........ | ........ | ...... | ...... |
| | Mairaira Pt.: Semaphore | 18 39 02 | 120 50 53 | ........ | ........ | ...... | ...... |
| | Aparri: Plaza | 18 21 43 | 121 37 27 | 5 43 | —0 02 | 3.2 | 1.9 |
| | Port San Vicente: San Vicente Islet | 18 28 32 | 122 04 14 | ........ | ........ | ...... | ...... |
| | Cape Engaño: Roña Islet | 18 32 02 | 122 05 49 | ........ | ........ | ...... | ...... |
| | Camiguin I.: Summit | 18 50 26 | 121 48 26 | 6 00 | —0 12 | 5.0 | 2.7 |
| | Fuga Island: W. summit. | 18 52 54 | 121 15 42 | ........ | ........ | ...... | ...... |
| | Dalupiri Island: Peak | 19 03 03 | 121 11 28 | ........ | ........ | ...... | ...... |
| | Calayan Island: NE. pt | 19 22 00 | 121 32 00 | ........ | ........ | ...... | ...... |
| | Babayan Claro Island: W. pt | 19 30 00 | 121 52 00 | ........ | ........ | ...... | ...... |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Balingtang Islands | 19 58 30 | 122 14 00 | | | | |
| | Batan Island: Mount Irada | 20 28 30 | 122 01 20 | | | | |
| | Ibayat Island: Mount Santa Rosa | 20 48 00 | 121 52 30 | | | | |
| | Yami Island: Islet off SW. part | 21 04 56 | 121 58 24 | | | | |
| | Luzon Island, Port Dimasalasan: Entrance | 17 20 17 | 122 19 20 | | | | |
| | Polillo I.: Port Polillo | 14 51 00 | 121 54 48 | | | | |
| | Tabaco: Church belfry | 13 21 33 | 123 43 53 | 6 08 | 0 00 | 5.2 | 2.8 |
| | Cautanduanco Islands: N. islet | 14 09 00 | 124 06 48 | | | | |
| | Cautanduanco Islands: S. extreme | 13 28 30 | 124 04 48 | | | | |
| | Point Calaan: S. extreme | 12 31 20 | 124 04 18 | | | | |
| | Port Sorsogon, Tinacos Islet | 12 52 20 | 123 49 22 | | | | |
| | Masbate Island, Palanog: Pier | 12 22 10 | 123 35 58 | | | | |
| | Bugui Pt. light-house | 12 36 00 | 123 14 36 | | | | |
| | Camasusu I.: Summit | 12 10 03 | 123 12 47 | | | | |
| | Tintolo Point: Extreme | 11 56 09 | 123 07 34 | | | | |
| | Burias Island: Busainga | 13 07 40 | 123 02 45 | [4 30] | [10 20] | [5.5] | |
| | Marinduque I.: Summit of Mount Catala. | 13 18 10 | 121 54 33 | | | | |
| | Maestro de Campo Island, Port Concepcion: Point Fernandez | 12 54 03 | 121 43 08 | | | | |
| | Banton Island: Banton Mountain | 12 56 56 | 122 04 48 | | | | |
| | Tablas Island: Tablas Head | 12 38 42 | 122 08 38 | | | | |
| | Sanguilan Pt | 12 33 44 | 121 58 32 | | | | |
| | Carabao Island: W. pt | 12 03 15 | 121 53 53 | | | | |
| | Romblon Island: Sabang Pt. light | 12 36 00 | 122 17 08 | | | | |
| | Summit over port | 12 35 33 | 122 16 26 | | | | |
| | Sibuyan Island: Summit | 12 24 55 | 122 33 23 | | | | |
| | Samar Island, Guiuan: Pier | 11 01 30 | 125 43 14 | | | | |
| | Catbalogan: Fort | 11 46 44 | 124 51 37 | | | | |
| | Maripipi Island: Summit | 11 47 30 | 124 18 15 | | | | |
| | Leyte, Tacloban | 11 15 08 | 124 59 56 | 6 53 | 1 25 | 1.5 | 1.1 |
| | Ormoc: Ast. station | 11 00 17 | 124 36 20 | | | | |
| | Palompon: Church | 11 02 37 | 124 22 07 | | | | |
| | Maasin | 10 07 39 | 124 50 15 | 11 47 | 4 50 | 2.8 | 2.0 |
| | Bohol I., Lapiniu I.: Mount Basiao | 10 03 22 | 124 32 35 | | | | |
| | Cebu Island, Cebu: Plaza | 10 17 30 | 123 54 18 | | | | |
| | Siquiquor Island, Port Canoan: S. pt. of entrance | 9 15 17 | 123 34 26 | | | | |
| | Negros Island, Port Bunbonon: E. pt. of entrance | 9 03 37 | 123 06 09 | | | | |
| | Dumaguete: Town | 9 18 25 | 123 18 43 | | | | |
| | Volcano of Malaspina, 8,192 ft | 10 24 35 | 123 07 05 | | | | |
| | Bacalod: Town | 10 40 21 | 122 55 42 | | | | |
| | Guimaras I., Inampulugan I., SW. pt | 10 26 38 | 122 40 20 | | | | |
| | Panay Island, Iloilo: Fort | 10 41 27 | 122 34 26 | 11 06 | 5 22 | 4.2 | 1.9 |
| | San José | 10 44 08 | 121 54 27 | | | | |
| | Pan de Azucar | 11 16 47 | 122 09 09 | | | | |
| | Batbatan Island: Summit | 11 28 20 | 121 52 36 | | | | |
| | Pucio Point: Extreme | 11 45 30 | 121 58 59 | | | | |
| | Port Batan: Village | 11 35 40 | 122 28 50 | | | | |
| | Capiz: Town | 11 35 06 | 122 45 03 | | | | |
| | Siargao Island, Port Sapao: Semaphore | 10 11 26 | 126 02 53 | | | | |
| | Gibdo Island: Semaphore | 9 53 00 | 125 31 17 | | | | |
| | Bucas Island: E. pt. of Port Sibanga | 9 41 34 | 125 58 22 | | | | |
| | Mindanao Island: Surigao | 9 47 53 | 125 28 30 | [11 40] | [6 15] | [6.5] | |
| | Cape St. Augustin | 6 14 30 | 125 47 48 | | | | |
| | Mindanao Island, Davao: Mole | 7 01 22 | 125 34 35 | 6 00 | −0 13 | 6.9 | 5.1 |
| | Saranguni Islets: W. islet | 5 22 30 | 125 13 48 | | | | |
| | Basianang Bay: N. pt. of Donauang I. | 6 28 50 | 123 57 37 | | | | |
| | Polloc: Small hill back of town | 7 21 15 | 124 11 42 | | | | |

*Coast label (left margin): Philippine Islands.*

MARITIME POSITIONS AND TIDAL DATA.

**EAST COAST OF ASIA—Continued.**

| Coast | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Philippine Islands. | Mindanao Island, Santa Cruz Islands: SE. islet.......... | 6 52 15 | 122 04 00 | ........ | ........ | ........ | ........ |
| | Zamboanga: Fort... | 6 54 03 | 122 04 52 | 6 50 | 0 42 | 3.8 | 2.8 |
| | Sibuco Bay: Hill S. of beach.......... | 7 18 05 | 122 03 18 | ........ | ........ | ........ | ........ |
| | Port Sta. Maria: Fort ............. | 7 45 41 | 122 04 58 | ........ | ........ | ........ | ........ |
| | Dapitan: Village.... | 8 40 15 | 123 23 13 | [10 48] | [4 50] | [5.1] | ........ |
| | Misamis: Fort ...... | 8 08 29 | 123 50 44 | ........ | ........ | ........ | ........ |
| | Camiguin Island: Mount Camiguin .... | 9 10 19 | 124 42 50 | ........ | ........ | ........ | ........ |
| | Sombrero Rock: Center................ | 10 43 00 | 121 33 00 | ........ | ........ | ........ | ........ |
| | Piedra Blanca: Center .............. | 10 27 00 | 121 03 00 | ........ | ........ | ........ | ........ |
| | Cagayanes Islands: Rocky islet between two larger islands ............. | 9 35 30 | 121 23 30 | ........ | ........ | ........ | ........ |
| | San Miguel Isles: E. pt. of Manuk Manukan ...................... | 7 43 00 | 118 27 00 | ........ | ........ | ........ | ........ |
| | Cagayan Jolo Island: Middle of W. coast ...................... | 7 00 38 | 118 26 06 | ........ | ........ | ........ | ........ |
| | Omapui Island: NW. extreme......... | 4 54 10 | 119 22 45 | ........ | ........ | ........ | ........ |
| | Sibutu Island: Hill on E. coast........ | 4 49 30 | 119 48 00 | ........ | ........ | ........ | ........ |
| | Simonor Island: NW. pt.............. | 4 55 30 | 119 46 45 | ........ | ........ | ........ | ........ |
| | Bahaltolis Island: Sandakan Harbor... | 5 50 00 | 118 11 00 | ........ | ........ | ........ | ........ |
| | Bongao Island: S. pt ............... | 5 00 30 | 119 44 15 | ........ | ........ | ........ | ........ |
| | Keenapoussan Island: Center ......... | 5 13 00 | 120 40 45 | ........ | ........ | ........ | ........ |
| | Bubuan Island: Lagoon entrance ...... | 5 25 15 | 120 35 00 | ........ | ........ | ........ | ........ |
| | Cuad Basang Island: SW. pt.......... | 5 27 10 | 120 11 30 | ........ | ........ | ........ | ........ |
| | Siassi: Town..................... | 5 32 40 | 120 48 25 | 5 54 | −0 18 | 8.6 | 6.4 |
| | Bulipongpong Island: Center hill....... | 5 41 30 | 120 49 45 | ........ | ........ | ........ | ........ |
| | Tapul Island: Center hill, 1,676 ft.... | 5 44 30 | 120 55 00 | ........ | ........ | ........ | ........ |
| | Jolo Islands: Maimbun Anchorage, dry bank.................. | 5 54 45 | 121 00 40 | ........ | ........ | ........ | ........ |
| | Dalrymple Harbor, Tulyan Islet ............... | 6 02 30 | 121 18 20 | ........ | ........ | ........ | ........ |
| | Jolo light-house ......... | 6 03 40 | 120 58 40 | [9 38] | [3 10] | [5.0] | ........ |
| | Doc Can Islet: W. extreme ............ | 5 52 30 | 119 55 55 | ........ | ........ | ........ | ........ |
| | Pangituran Island: SW. pt........... | 6 15 15 | 120 29 30 | ........ | ........ | ........ | ........ |
| | Basilan Island: La Isabela ............ | 6 42 43 | 121 56 50 | ........ | ........ | ........ | ........ |
| China. | Wang-kia-tia Bay: Langwang temple .. | 35 39 00 | 119 51 30 | ........ | ........ | ........ | ........ |
| | Kyauchau Bay: Yunuisan light......... | 36 02 50 | 120 17 30 | 4 50 | 11 03 | 11.4 | 6.0 |
| | Staunton Island: Landing place, N. side.. | 36 45 29 | 122 16 48 | ........ | ........ | ........ | ........ |
| | Shantung Promontory: Light-house ... | 37 24 00 | 122 42 00 | 4 00 | 10 12 | 6.8 | 5.0 |
| | Weihaiwei: Light, S. side harbor...... | 37 27 41 | 122 15 05 | 9 20 | 3 08 | 9.0 | 6.6 |
| | Chifu: Light-house ................... | 37 34 10 | 121 31 09 | 10 25 | 4 13 | 8.1 | 6.0 |
| | Fort flagstaff ............ | 37 32 51 | 121 21 27 | ........ | ........ | ........ | ........ |
| | Miautao Island: Peak of N. Island..... | 38 23 37 | 120 55 00 | ........ | ........ | ........ | ........ |
| | Pei-ho: S. Taku Fort, S. Cavalier ...... | 38 58 16 | 117 42 48 | ........ | ........ | ........ | ........ |
| | Tientsin: Shore opp. NE. angle of wall.. | 39 09 00 | 117 11 44 | 6 50 | 1 00 | 4.5 | 3.3 |
| | Shaluitien Island: Light-house ......... | 38 56 00 | 118 31 00 | ........ | ........ | ........ | ........ |
| | Niuchwang: Lightship............... | 40 35 00 | 122 00 00 | 4 30 | 10 50 | 11.7 | 8.7 |
| | Hulu-shan Bay: N. side.............. | 39 30 46 | 121 18 03 | ........ | ........ | ........ | ........ |
| | Port Adams: Entry.................. | 39 16 00 | 121 35 59 | ........ | ........ | ........ | ........ |
| | Liao-ti-shan Promontory: SW. pt. light | 38 43 17 | 121 08 26 | ........ | ........ | ........ | ........ |
| | Port Arthur: Obs. spot................ | 38 47 50 | 121 15 54 | 10 05 | 3 53 | 7.5 | 5.5 |
| | Ta-lien-wan Bay: Isthmus on S. San-shan I .............. | 38 52 38 | 121 51 59 | ........ | ........ | ........ | ........ |
| | Round Island: Summit .............. | 38 40 00 | 122 11 30 | ........ | ........ | ........ | ........ |
| | Thornton Haven, Hai-yun-tan Island: Beach opposite Temple Point........ | 39 04 00 | 123 10 34 | ........ | ........ | ........ | ........ |
| Korea. | Choda Island: S. pt................. | 38 27 00 | 124 34 40 | ........ | ........ | ........ | ........ |
| | Sir James Hall Islands: N. island.... | 37 58 00 | 124 34 30 | ........ | ........ | ........ | ........ |
| | Chemulpo: So Wolmi................ | 37 27 40 | 126 36 27 | 4 19 | 10 31 | 28.8 | 11.6 |
| | Marjoribanks Harbor: Manzoc Islet.... | 36 26 45 | 126 28 00 | ........ | ........ | ........ | ........ |
| | Tas de foin Islet: Center ............ | 36 24 30 | 126 24 00 | ........ | ........ | ........ | ........ |
| | Guerin Island: Summit, 969 ft........ | 36 07 00 | 126 01 09 | ........ | ........ | ........ | ........ |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range Spg. | Range Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Korea. | Kokoun-tan Islands: Camp Islet....... | 35 48 08 | 126 31 00 | ........ | ........ | ...... | ...... |
| | Barren Island: Center, 600 ft........... | 35 21 00 | 125 58 00 | ........ | ........ | ...... | ...... |
| | Sea Rock: Center, 160 ft............... | 34 42 00 | 126 19 45 | ........ | ........ | ...... | ...... |
| | Modeste Island: N. peak, 1,228 ft....... | 34 42 30 | 125 16 00 | ........ | ........ | ...... | ...... |
| | Ross Island: Peak, 1,920 ft............. | 34 06 00 | 125 07 00 | ........ | ........ | ...... | ...... |
| | Kuper Harbor: N.E. extreme of Josling I. | 34 17 20 | 126 35 28 | ........ | ........ | ...... | ...... |
| | Port Hamilton: W. pt. of Obs. Island.. | 34 01 23 | 127 18 34 | 9 05 | 2 52 | 10.5 | 4.2 |
| | Bate Islands: Summit Thornton Islet... | 33 57 00 | 126 18 00 | ........ | ........ | ...... | ...... |
| | Montravel Island: Center, 1,041 feet.... | 33 59 00 | 126 55 00 | ........ | ........ | ...... | ...... |
| | Quelpart Island: Beaufort I., middle of W. side.... | 33 29 40 | 126 58 25 | ........ | ........ | ...... | ...... |
| | Observation Island: Point of W. arm... | 34 39 00 | 128 14 00 | ........ | ........ | ...... | ...... |
| | Sentinel Island: Summit, 400 feet....... | 34 33 00 | 128 40 00 | ........ | ........ | ...... | ...... |
| | Broughton Head: Extreme............. | 34 48 00 | 128 44 00 | ........ | ........ | ...... | ...... |
| | Tsau-liang-hai Harbor: Light-house.... | 35 07 15 | 129 02 10 | 7 35 | 1 23 | 7.0 | 3.0 |
| Japan. | Tsu Sima: Observation rock........... | 34 18 55 | 129 13 06 | 8 56 | 2 44 | 6.7 | 2.4 |
| | Iki Sima: Summit, S. end of island..... | 33 44 30 | 129 42 30 | ........ | ........ | ...... | ...... |
| | Oro No Sima: Summit, 277 ft........... | 33 52 10 | 130 02 00 | ........ | ........ | ...... | ...... |
| | Kosime No Osima: Summit Wilson I... | 33 53 50 | 130 25 20 | ........ | ........ | ...... | ...... |
| | Yeboshi Sima: Light-house ............ | 33 41 30 | 129 58 50 | ........ | ........ | ...... | ...... |
| | Yobuko Harbor: Bluff opposite Nicoya. | 33 32 30 | 129 52 43 | 9 23 | 3 10 | 6.4 | 2.5 |
| | Hirado No Seto: Taske light........... | 33 23 31 | 129 33 21 | ........ | ........ | ...... | ...... |
| | Goto Island: Ose Saki light........... | 32 36 45 | 128 36 10 | ........ | ........ | ...... | ...... |
| | Pallas Rocks: S. rock ................. | 32 13 12 | 128 04 39 | ........ | ........ | ...... | ...... |
| | Meiaco Sima: Ears Peak .............. | 32 03 00 | 128 25 00 | ........ | ........ | ...... | ...... |
| | Nagasaki: Transit Venus Station....... | 32 43 21 | 129 52 25 | 7 54 | 1 41 | 8.4 | 3.5 |
| | Kuchinotsu: Light-house ............. | 32 36 05 | 130 13 40 | ........ | ........ | ...... | ...... |
| | Kagoshima: Breakwater light ......... | 31 35 39 | 130 33 49 | 6 40 | 1 00 | 10.5 | 4.4 |
| | Tsukarase Rocks: Summit, 96 ft ....... | 31 20 00 | 129 46 20 | ........ | ........ | ...... | ...... |
| | Uji Shima: High peak, 1,097 ft ........ | 31 12 00 | 129 29 00 | ........ | ........ | ...... | ...... |
| | Yamagawa Harbor: Spit N. of town.... | 31 12 43 | 130 37 00 | 7 20 | 1 08 | 9.5 | 3.9 |
| | Satano Misaki: Light-house ........... | 30 59 30 | 130 39 30 | ........ | ........ | ...... | ...... |
| Linschoten Is. | Kusakaki Jima: Ingersoll Rocks, 530 ft. | 30 51 00 | 129 28 00 | ........ | ........ | ...... | ...... |
| | Kuro Sima: 2,160 ft................... | 30 50 00 | 129 55 30 | ........ | ........ | ...... | ...... |
| | Iwo Shima: Peak, 2,469 ft............. | 30 47 00 | 130 18 00 | ........ | ........ | ...... | ...... |
| | Yakuno Shima: Mount Matomi, 6,252 ft. | 30 17 00 | 130 32 00 | ........ | ........ | ...... | ...... |
| | Firase Rocks: Highest, 92 ft........... | 30 05 00 | 130 03 00 | ........ | ........ | ...... | ...... |
| | Kuchino Shima: Summit, 2,230 ft ..... | 29 59 00 | 129 56 00 | ........ | ........ | ...... | ...... |
| | Guaja Shima: Summit, 1,687 ft ........ | 29 54 00 | 129 33 00 | ........ | ........ | ...... | ...... |
| | Naka no Shima: Peak, 3,400 ft ........ | 29 52 00 | 129 52 30 | ........ | ........ | ...... | ...... |
| | Suwanose Jima: Volcano, 2,706 ft ..... | 29 38 00 | 129 42 00 | ........ | ........ | ...... | ...... |
| | Tokara Jima: Summit, 860 ft.......... | 29 08 00 | 129 13 30 | ........ | ........ | ...... | ...... |
| | Yoko Shima: Summit, 1,700 ft ........ | 28 47 30 | 129 01 30 | ........ | ........ | ...... | ...... |
| Japan. | Shimonoseki Strait: Meji Zaki, extreme. | 33 57 46 | 130 57 50 | ........ | ........ | ...... | ...... |
| | Rokuren Island: Light-house........... | 33 58 53 | 130 52 07 | 8 30 | 2 20 | 6.7 | 2.4 |
| | Shirasu Reef: Light-house ............ | 33 59 11 | 130 47 36 | ........ | ........ | ...... | ...... |
| | Susaki: SW. battery................... | 33 23 19 | 133 17 00 | 5 55 | 12 08 | 5.0 | 2.0 |
| | Tomo Roads: Tamatsu Sima............ | 34 22 37 | 133 23 23 | 11 16 | 5 04 | 10.2 | 4.5 |
| | Port Okayama: Take Sima temple..... | 34 35 58 | 133 59 24 | ........ | ........ | ...... | ...... |
| | Wusimado Pt.: Wusimado Peak, 548 ft. | 34 37 27 | 134 09 21 | ........ | ........ | ...... | ...... |
| | Akashi-no-seto: Maico Fort ........... | 34 38 05 | 135 01 51 | ........ | ........ | ...... | ...... |
| | Hiogo: Wada Misaki light ............ | 34 39 20 | 135 10 56 | ........ | ........ | ...... | ...... |
| | Kobe: Light-house ................... | 34 41 18 | 135 11 34 | ........ | ........ | ...... | ...... |
| | Osaka: Fort Temposan light........... | 34 39 45 | 135 26 00 | 7 30 | 1 25 | 4.7 | 2.0 |
| | Sakai: Pier-head light ................. | 34 35 12 | 135 27 44 | ........ | ........ | ...... | ...... |
| | Osaki Bay: Tree Islet, S. pt ........... | 34 07 42 | 135 08 19 | ........ | ........ | ...... | ...... |
| | Yura No Uchi: Pier ................... | 33 57 34 | 135 07 21 | ........ | ........ | ...... | ...... |
| | Tanabe Bay: Fossil pt ................ | 33 41 14 | 135 23 04 | ........ | ........ | ...... | ...... |
| | Oö-sima Hbr.: Kashinosaki light, E. pt. | 33 28 15 | 135 51 59 | ........ | ........ | ...... | ...... |
| | Uragami Harbor: Village pt........... | 33 33 37 | 135 54 25 | ........ | ........ | ...... | ...... |
| | Owashi Bay: Hikimoto ............... | 34 06 10 | 136 14 35 | ........ | ........ | ...... | ...... |
| | Mura Harbor: Osima Islet ........... | 34 13 52 | 136 48 51 | 6 23 | 0 10 | 4.7 | 2.0 |

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | o ' '' | o ' '' | h. m. | h. m. | ft. | ft. |
| | Matoya Harbor: Anori-saki light | 34 21 57 | 136 54 09 | 5 52 | 12 04 | 4.3 | 1.7 |
| | Omoi Saki: Light-house | 34 35 52 | 138 13 49 | | | | |
| | Shimizu Bay: Mound on pt | 35 00 51 | 138 31 19 | 5 52 | 12 04 | 3.9 | 1.6 |
| | Mikomoto Island: Light-house | 34 34 25 | 138 56 30 | | | | |
| | Simoda Harbor: Center I | 34 39 49 | 138 57 30 | | | | |
| | Yokosuka Harbor: Eyi Yama pt | 35 17 30 | 139 39 43 | | | | |
| | Yokohama: English Hatoba light | 35 26 52 | 139 38 41 | 5 25 | 11 30 | 4.9 | 1.9 |
| | Tokio: Naval Observatory | 35 39 18 | 139 44 30 | | | | |
| | No Sima Saki: Light-house | 34 54 17 | 139 53 24 | 5 04 | 11 17 | 3.7 | 1.4 |
| | Vries Island (O Sima) Volcano: Summit, 2,512 ft | 34 43 30 | 139 23 00 | | | | |
| | Kozu Shima Volcano: Summit, 2,000 ft. | 34 13 15 | 139 08 00 | | | | |
| | Mikake Jima: Summit, 2,690 ft | 34 05 00 | 139 31 00 | | | | |
| | Redfield Rocks: S. rock | 33 56 50 | 138 48 15 | | | | |
| | Mikura Jima: Summit | 33 52 00 | 139 34 00 | | | | |
| | Broughton Rock: Summit, 60 ft | 33 39 00 | 139 17 45 | | | | |
| | Fatsizio Island: Observation spot | 33 04 24 | 139 50 24 | | | | |
| | Aoga Shima: Center | 32 29 00 | 139 43 31 | | | | |
| | Bayonnaise Island: Summit, 26 ft | 32 00 40 | 140 00 00 | | | | |
| Japan. | Smith Island: Summit, 250 ft | 31 27 00 | 140 02 00 | | | | |
| | Ponafidin Island: Summit, 1,328 ft | 30 28 26 | 140 14 02 | | | | |
| | Lots Wife Rock: Summit, 300 ft | 29 46 28 | 140 19 40 | | | | |
| | Inaboye Saki: Light-house | 35 42 13 | 140 52 22 | | | | |
| | Kinkwosan Island: Light-house | 38 16 57 | 141 35 33 | | | | |
| | Kamaishi Harbor: SE. end of village | 39 16 30 | 141 52 50 | | | | |
| | Yamada Harbor: Ko Sima, 90 ft | 39 27 17 | 141 59 00 | 4 30 | 10 45 | 3.4 | 1.3 |
| | Siriya Saki: Light-house | 41 25 58 | 141 27 32 | | | | |
| | Toriwi Saki: Center of Low Islet off | 41 33 34 | 140 56 36 | | | | |
| | Awomori: Light-house | 40 50 00 | 140 44 40 | | | | |
| | Tatsupi Saki: N. side | 41 16 17 | 140 22 37 | | | | |
| | Bittern Rocks: SW. rock | 40 31 00 | 139 31 00 | | | | |
| | Tobi Shima: Takamori Yama | 39 12 02 | 139 32 58 | | | | |
| | Awa Sima: NE. extreme | 38 29 23 | 139 15 31 | | | | |
| | Sado Island: Ya Saki | 38 19 55 | 138 27 09 | | | | |
| | Fushiki Harbor: Light-house | 36 47 47 | 137 03 15 | | | | |
| | Cape Roigen: Extreme | 37 28 00 | 137 22 00 | | | | |
| | Niigata: Buddhist temple | 37 55 14 | 139 03 01 | | | | |
| | Mana Sima: Summit, 200 ft | 37 35 00 | 136 54 00 | | | | |
| | Manao Harbor: Sorenjo Pt | 37 02 37 | 136 58 24 | | | | |
| | Tsuruga: Town | 35 40 24 | 136 01 22 | 2 30 | 8 42 | 0.6 | 0.4 |
| | Oki Islands: N. pt | 36 30 00 | 133 23 00 | | | | |
| | Taka Yama (Cape Louisa): Extreme | 34 40 00 | 131 36 00 | 11 41 | 5 28 | 1.1 | 0.5 |
| | Ai Sima: Summit, 300 ft | 34 32 00 | 131 18 00 | | | | |
| | Mino Sima: Summit, 492 ft | 34 48 00 | 131 09 00 | | | | |
| | Kado Sima: Tsuno Shima light | 34 21 12 | 130 50 29 | | | | |
| | Hakodate: Light-ship | 41 47 36 | 140 41 49 | 3 40 | 10 00 | 3.0 | 1.2 |
| | Endermo Harbor: Bluff on E. side | 42 19 54 | 140 59 33 | 3 32 | 9 45 | 3.5 | 1.5 |
| | Okishi Bay: Light-house | 42 56 52 | 144 52 38 | 3 41 | 9 53 | 3.0 | 1.4 |
| | Noshiaf Saki: Light-house | 43 22 56 | 145 49 10 | 3 48 | 10 00 | 3.1 | 1.4 |
| | Nemuro: Benten Sima light | 43 20 22 | 145 34 40 | 3 33 | 9 46 | 2.1 | 0.5 |
| | Notsuke Anchorage: Village | 43 33 11 | 145 18 00 | 4 50 | 11 05 | 3.7 | 1.8 |
| | Noshiaf Misaki: Light-house | 45 26 30 | 141 38 40 | | | | |
| | Risiri Islet: Peak, 5,713 ft | 45 11 00 | 141 19 00 | | | | |
| | Kunashir Island: St. Anthonys Peak | 44 20 00 | 146 15 00 | | | | |
| | Iturup Island: NE. pt | 45 38 30 | 149 14 00 | | | | |
| | Urup Island: Cape Vanderlind | 45 37 00 | 149 34 00 | | | | |
| | Broughton Island: Summit | 46 42 30 | 150 28 30 | | | | |
| | Simusir Island: Prevost Peak | 47 02 50 | 151 52 50 | | | | |
| Kuril Islands. | Ketoy Island: S. pt | 47 17 30 | 152 24 00 | | | | |
| | Matana Island: Peak | 48 06 00 | 153 12 30 | | | | |
| | Shiash-Kotan Island: Center | 48 52 00 | 154 08 00 | | | | |
| | Kharim-Kotan Island: Peak | 49 08 00 | 154 39 00 | | | | |
| | Oune-Kotan Island: SW. pt | 49 19 00 | 154 44 00 | | | | |
| | Moukon rushi Island: Center | 49 51 00 | 154 32 00 | | | | |
| | Poro musir Island: Fool's Peak | 50 15 36 | 156 15 20 | | | | |
| | Soumshu Island: Center | 50 46 00 | 156 26 00 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### EAST COAST OF ASIA—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Korea.** | Cape Clonard: Extreme | 36 05 45 | 129 33 30 | | | | |
| | Ping-hai Harbor | 36 36 00 | 129 20 00 | | | | |
| | Liancourt Rocks: Summit, 410 ft | 37 09 30 | 131 55 00 | | | | |
| | Matu Sima: Peak, 4,000 ft | 37 30 00 | 130 53 00 | | | | |
| | Port Lazaref: S. 1½ miles from the S. end of Bontenef I | 39 19 12 | 127 32 48 | | | | |
| **Siberia.** | Wawoda Rock: Summit, 12 ft | 42 14 30 | 137 17 00 | | | | |
| | Expedition Bay: Light-house | 42 38 05 | 130 48 45 | | | | |
| | Port Novogorod: Light-house | 42 33 40 | 131 10 00 | | | | |
| | Vladivostok: Cape Galdobin light | 43 05 13 | 131 53 56 | 2 45 | 9 00 | 1.9 | 0.8 |
| | Cape Povorotnyi: Light-house | 42 41 00 | 133 02 00 | | | | |
| | Port Olga: Light-house | 43 22 00 | 135 15 00 | | | | |
| | St. Vladimir Bay: Orekhera Pt | 43 53 40 | 135 27 19 | | | | |
| | Shelter Bay | 44 30 00 | 136 02 00 | | | | |
| | Sybillo Bay | 44 43 45 | 136 22 30 | | | | |
| | Pique Bay | 44 46 15 | 136 27 15 | | | | |
| | Bullock Bay | 45 05 00 | 136 44 00 | | | | |
| | Luké Point: Extreme | 45 19 30 | 137 10 15 | | | | |
| | Cape Disappointment: Extreme | 45 41 30 | 137 38 15 | | | | |
| | Cape Suffren: Extreme | 47 20 00 | 138 58 00 | | | | |
| | Cape St. Nikolaia: Light-house | 48 59 30 | 140 23 40 | 9 50 | 3 40 | 2.7 | 1.1 |
| | De Kastri: Light-house | 51 28 00 | 140 48 00 | 10 45 | 4 40 | 6.3 | 2.6 |
| | Sakhalin I., Cape Notoro: Light-house | 45 53 10 | 142 04 51 | | | | |
| | Cape Siretoku: Extreme | 46 01 20 | 143 26 30 | | | | |
| | Cape Elizabeth: N. pt | 54 24 30 | 142 46 30 | 11 20 | 5 08 | 4.2 | 1.7 |
| | Nikolaevsk: Cathedral | 53 08 05 | 140 42 58 | | | | |
| | Great Shantar Island: N. pt | 55 11 00 | 137 40 00 | | | | |
| | Port Aian: Cape Vneshni | 56 25 28 | 138 25 50 | 0 10 | 7 30 | 8.4 | 3.4 |
| | St. Jona Island: Summit, 1,200 ft | 56 22 30 | 143 15 45 | | | | |
| | Okhotsk: Battery | 59 19 45 | 143 07 14 | | | | |
| | Cape Lopatka: Extreme | 51 02 00 | 156 46 00 | 3 55 | 10 08 | 4.6 | 1.9 |
| | Petropavlovsk: Rakof light | 52 52 37 | 158 46 42 | 3 30 | 9 45 | 5.1 | 2.1 |
| | Cape Shipunski: Extreme | 53 04 30 | 160 04 00 | | | | |
| | Bering Island: Cape Khitroff | 54 56 00 | 166 43 00 | | | | |
| | Mednoi, or Copper Island: SE. extreme | 54 32 24 | 168 09 00 | | | | |
| | Cape Kamchatka: Extreme | 56 10 00 | 163 24 00 | | | | |
| | Karajinski Island: S. pt | 58 26 00 | 163 34 00 | | | | |
| | Cape Oliutorski: Extreme, 2,480 ft | 59 55 00 | 170 22 00 | 6 00 | 12 15 | 4.5 | 1.8 |
| | Cape Navarin: Extreme, 2,512 ft | 62 14 30 | 179 04 30 | | | | |
| | | | Long. W. | | | | |
| | St. Matthew Island: Cape Upright, SE. pt | 60 18 00 | 172 04 00 | | | | |
| | St. Lawrence Island: N. pt | 63 12 00 | 159 50 00 | | | | |
| | Cape Tchoukotskoi: Extreme | 64 16 00 | 173 10 00 | | | | |
| | Port Providence: Emma Harbor | 64 25 55 | 173 07 15 | | | | |
| | Cape Indian: Extreme | 64 24 30 | 172 12 30 | | | | |
| | Arakam Island: Cape Kiguinin | 64 46 00 | 172 07 00 | | | | |
| | | | Long. E. | | | | |
| | Anadir River: Mouth | 64 50 00 | 178 40 00 | | | | |
| | | | Long. W. | | | | |
| | Cape Bering: Extreme | 65 00 30 | 175 54 00 | | | | |
| | East Cape: Extreme | 66 02 00 | 169 32 30 | | | | |

### ISLANDS OF THE PACIFIC.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | Malpelo Island: Summit, 1,200 ft | 4 03 00 | 81 36 00 | | | | |
| | Cocos Island: Head of Chatham Bay | 5 32 57 | 86 59 17 | | | | |
| **Galapagos.** | Redondo Rock: Summit, 85 ft | 0 13 30 | 91 03 00 | | | | |
| | Towers Island: W. cliff | 0 20 00 | 89 58 43 | | | | |
| | Bindloe Island: S. summit | 0 18 50 | 90 30 08 | | | | |
| | Abingdon Island: Summit, 1,950 ft | 0 34 25 | 90 44 23 | | | | |
| | Wenman Island: Summit, 550 ft | 1 22 55 | 91 49 43 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

**ISLANDS OF THE PACIFIC—Continued.**

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Galapagos Islands.** | Albemarle Island: Iguana Cove ........ | 0 59 00 | 91 29 12 | 2 00 | 8 13 | 6.2 | 3.1 |
| | Marlborough Island: Cape Hammond.. | 0 31 00 | 91 36 00 | ........ | ........ | ........ | ........ |
| | James Island: Sugarloaf, 1,200 ft ...... | 0 15 20 | 90 52 53 | 2 45 | 8 58 | 5.2 | 2.6 |
| | Jervis Island: Summit ................... | 0 25 00 | 90 43 30 | ........ | ........ | ........ | ........ |
| | Duncan Island: Center hill............. | 0 36 30 | 90 41 00 | ........ | ........ | ........ | ........ |
| | Indefatigable Island: NW. bay ........ | 0 33 25 | 90 33 58 | 2 00 | 8 13 | 6.2 | 3.1 |
| | Barrington Island: W. summit, 900 ft.. | 0 50 30 | 90 06 13 | ........ | ........ | ........ | ........ |
| | Charles Island: Summit, 1,780 ft ...... | 1 19 00 | 90 28 13 | 2 10 | 8 23 | 6.0 | 3.0 |
| | Fatu Huku or Hood Island: E. summit, 640 ft .................... | 1 25 00 | 89 40 08 | ........ | ........ | ........ | ........ |
| | Chatham Island: Mount Pitt, 800 ft.... | 0 44 15 | 89 16 58 | 2 20 | 8 33 | 6.5 | 3.3 |
| | | Lat. N. | | | | | |
| | Christmas Island: N. pt. of Cook Islet.. | 1 57 17 | 157 27 45 | 4 25 | 10 38 | 2.4 | 1.4 |
| | Fanning Island: Flagstaff, entrance to English Hbr ...................... | 3 51 26 | 159 21 50 | 6 00 | 12 15 | 2.4 | 1.4 |
| | Washington Island ..................... | 4 41 10 | 160 24 30 | ........ | ........ | ........ | ........ |
| | Palmyra Island...................... | 5 52 15 | 162 05 00 | 5 25 | 11 40 | 1.5 | 0.9 |
| | Baker Islet: Center.................... | 0 13 30 | 176 32 39 | ........ | ........ | ........ | ........ |
| | Howland Islands: Center island ....... | 0 49 00 | 176 43 09 | 7 10 | 1 00 | 6.2 | 3.6 |
| | | Lat. S. | Long. E. | | | | |
| **Gilbert Islands.** | Arorai or Hurds Island: S. pt ......... | 2 40 54 | 177 01 13 | ........ | ........ | ........ | ........ |
| | Tamana Island: Center ................ | 2 35 00 | 176 07 00 | ........ | ........ | ........ | ........ |
| | Onoatoa Island: Center ............... | 1 50 00 | 175 39 00 | ........ | ........ | ........ | ........ |
| | Taputeuea or Drummond Island: SE. pt. | 1 29 14 | 175 12 20 | ........ | ........ | ........ | ........ |
| | Nukunau or Byron Island: SE. pt...... | 1 23 42 | 176 31 33 | ........ | ........ | ........ | ........ |
| | Peru or Francis Island: NW. pt ........ | 1 17 14 | 175 57 09 | ........ | ........ | ........ | ........ |
| | Nonuti or Sydenham Island............ | 0 36 00 | 174 24 00 | ........ | ........ | ........ | ........ |
| | | Lat. N. | | | | | |
| | Aranuka or Henderville Island: W. pt. of W. island...................... | 0 11 10 | 173 32 40 | ........ | ........ | ........ | ........ |
| | Apamama or Hoppers Island: Entrance islet ............................. | 0 20 54 | 173 51 14 | 4 30 | 10 45 | 4.7 | 2.7 |
| | Maiana Island: S. pt.................... | 0 51 30 | 173 03 30 | ........ | ........ | ........ | ........ |
| | Tarawa Island: NE. pt................. | 1 38 45 | 173 03 00 | ........ | ........ | ........ | ........ |
| | Apaiang Island: S. pt.................. | 1 44 15 | 173 07 00 | 4 45 | 11 00 | 4.7 | 2.7 |
| | Maraki Island: N. pt .................. | 2 03 00 | 173 25 30 | ........ | ........ | ........ | ........ |
| | Taritari Island: S. pt ................. | 3 01 30 | 172 45 40 | ........ | ........ | ........ | ........ |
| **Marshall Islands.** | Ebon Atoll: Rube Pt .................. | 4 35 25 | 168 41 31 | 4 45 | 11 00 | 4.7 | 2.7 |
| | Jaluit or Bonham Islands: Jarbor Pier.. | 5 55 07 | 169 39 31 | ........ | ........ | ........ | ........ |
| | Burrh Island: Port Rhin, N. pt. of entrance ......................... | 6 14 00 | 171 46 00 | 5 00 | 11 15 | 5.0 | 2.8 |
| | Majuro or Arrowsmith Islands: Anchorage Djarrit I ................. | 7 05 30 | 171 24 30 | ........ | ........ | ........ | ........ |
| | Arno Atoll: NE. pt .................... | 7 09 17 | 171 55 51 | ........ | ........ | ........ | ........ |
| | Odia Islands: S. islet.................. | 7 15 00 | 168 46 00 | ........ | ........ | ........ | ........ |
| | Namu Island: S. pt .................... | 8 14 00 | 168 03 00 | ........ | ........ | ........ | ........ |
| | Jabwat Island: Center ................ | 8 27 00 | 168 26 00 | ........ | ........ | ........ | ........ |
| | Aurh or Ibbetson Island: NE. end, anchorage .......................... | 8 19 00 | 171 09 00 | ........ | ........ | ........ | ........ |
| | Maloclab Islands: NW. end Karen Islet. | 8 54 21 | 170 49 00 | ........ | ........ | ........ | ........ |
| | Wotje or Romanzov Islands: Christmas Harbor ....................... | 9 28 09 | 170 16 05 | | | | |
| | Litkieh Island: NW. pt................ | 10 03 40 | 169 01 57 | ........ | ........ | ........ | ........ |
| | Ailuk Islands: Capeniur Islet ......... | 10 17 25 | 169 59 20 | 4 50 | 11 00 | 6.2 | 3.6 |
| | Bigar Islet: Center ................... | 11 48 00 | 170 07 00 | ........ | ........ | ........ | ........ |
| | Kongelab or Pescadores Islands: Center of group ......................... | 11 19 21 | 167 24 57 | ........ | ........ | ........ | ........ |
| | Rongerik or Radakala Islands: Observation spot......................... | 11 24 00 | 167 35 00 | ........ | ........ | ........ | ........ |
| | Ailinginae Island: Easternmost Islet... | 11 07 00 | 166 35 00 | ........ | ........ | ........ | ........ |
| | Bikini or Eschholtz Islands: W. extreme ............................. | 11 40 00 | 166 24 25 | ........ | ........ | ........ | ........ |
| | Wottho or Schanz Island: Center...... | 10 05 00 | 166 04 00 | ........ | ........ | ........ | ........ |
| | Eniwetok Islands: North or Engibi I... | 11 40 00 | 162 15 00 | ........ | ........ | ........ | ........ |
| | Ujelang or Providence Island: Center of atoll.............................. | 9 39 00 | 161 08 30 | ........ | ........ | ........ | ........ |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### ISLANDS OF THE PACIFIC—Continued.

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Greenwich Island: Northern islet...... | 1 04 00 | 154 47 55 | ........ | ........ | ........ | ........ |
| Caroline Islands. | Matelotas group: Easternmost of the S. islands....................... | 8 18 30 | 137 33 30 | ........ | ........ | ........ | ........ |
| | Yap Island: Light in Tomil Bay........ | 9 29 00 | 138 04 00 | 7 15 | 1 00 | 3.4 | 1.9 |
| | Eau Island: Center................... | 9 52 30 | 139 42 00 | ........ | ........ | ........ | ........ |
| | Uluthi or Mackenzie Islands: Mogmog Islet........................... | 10 06 00 | 139 46 00 | ........ | ........ | ........ | ........ |
| | Feys or Tromelin Island: E. extreme .. | 9 46 00 | 140 35 00 | ........ | ........ | ........ | ........ |
| | Sorol or Philip Island: Center......... | 8 06 00 | 140 52 00 | ........ | ........ | ........ | ........ |
| | Eauripik or Kama Islands: E. islet .... | 6 40 00 | 143 11 00 | ........ | ........ | ........ | ........ |
| | Oleai group: Raur Islet, N. pt ......... | 7 21 45 | 143 57 30 | ........ | ........ | ........ | ........ |
| | Ifalik or Wilson Islets: N. end ........ | 7 15 00 | 144 31 00 | ........ | ........ | ........ | ........ |
| | Faraulep Island: S. end............... | 8 35 00 | 144 36 00 | ........ | ........ | ........ | ........ |
| | W. Faiu Islet: Center................. | 8 03 00 | 146 50 00 | ........ | ........ | ........ | ........ |
| | Olimarao Islet: Center................ | 7 43 30 | 145 55 45 | ........ | ........ | ........ | ........ |
| | Toass Island: Center.................. | 7 29 30 | 146 24 30 | ........ | ........ | ........ | ........ |
| | Satawal Island: Center................ | 7 22 00 | 147 06 48 | ........ | ........ | ........ | ........ |
| | Coquille or Pikelot Island: Center ..... | 8 09 00 | 147 42 00 | ........ | ........ | ........ | ........ |
| | Suk or Polusuk Island: S. end......... | 6 40 00 | 149 21 00 | ........ | ........ | ........ | ........ |
| | Los Martires: Ollap Islet, N. pt........ | 7 38 00 | 149 27 30 | ........ | ........ | ........ | ........ |
| | Namonuito Islands: Magur Islet........ | 8 59 45 | 150 14 30 | ........ | ........ | ........ | ........ |
| | Hall Island: Namuine Islet............ | 8 25 30 | 151 49 15 | ........ | ........ | ........ | ........ |
| | Hogolu (Hogulu) Group: N. end of Tsis Islet......................... | 7 18 30 | 151 56 30 | ........ | ........ | ........ | ........ |
| | Namoluk Islands: NW. islet ........... | 5 55 00 | 153 13 30 | ........ | ........ | ........ | ........ |
| | Mortlock Islands: Lukanor, Port Chamisso .............................. | 5 29 18 | 153 58 00 | ........ | ........ | ........ | ........ |
| | Nukuor or Monteverde Islands: E. pt.. | 3 51 00 | 155 00 54 | ........ | ........ | ........ | ........ |
| | Oraluk or Bordelaise Island: Center ... | 7 39 00 | 155 05 00 | ........ | ........ | ........ | ........ |
| | Ngatik or Valientes Islands: E. extreme. | 5 48 00 | 157 31 30 | ........ | ........ | ........ | ........ |
| | Ponapi Island: Jamestown Harbor..... | 7 00 35 | 158 12 21 | 4 00 | 10 15 | 4.3 | 2.4 |
| | Mokil or Duperrey Islands: Aoura, NE.pt | 6 41 45 | 159 50 00 | ........ | ........ | ........ | ........ |
| | Pingelasp or MacAskill Islands: E. end of island .......................... | 6 14 00 | 160 38 43 | ........ | ........ | ........ | ........ |
| | Ualan or Strong Island: Chabrol Harbor. | 5 20 06 | 163 00 45 | 6 00 | 12 15 | 3.5 | 2.0 |
| Pelew Islands. | Angaur Island: SW. pt................. | 6 53 55 | 134 05 24 | ........ | ........ | ........ | ........ |
| | Pililu Island: S. pt .................... | 7 02 00 | 133 18 03 | ........ | ........ | ........ | ........ |
| | Earakong or Akamokan Island: Center. | 7 08 00 | 134 27 00 | ........ | ........ | ........ | ........ |
| | Korror Islands: Korror Harbor, Malakal pier........................... | 7 19 00 | 134 32 30 | ........ | ........ | ........ | ........ |
| | Baubeltaub Island: Cape Artingal ..... | 7 40 30 | 134 39 30 | ........ | ........ | ........ | ........ |
| | Kyangle Islets: Center of largest ...... | 8 08 00 | 134 17 00 | ........ | ........ | ........ | ........ |
| | Warren Hastings Island: Center........ | 4 20 00 | 132 21 00 | ........ | ........ | ........ | ........ |
| | Nevil or Lord North Island: Center.... | 3 02 00 | 131 11 00 | ........ | ........ | ........ | ........ |
| | Sonserol Island: Approx ............... | 5 20 00 | 132 16 00 | ........ | ........ | ........ | ........ |
| Ladrone (or Mariana) Islands. | Guam Island: Fort Sta. Cruz, San Luis d'Apra............................. | 13 25 48 | 144 39 30 | 7 20 | 1 20 | 2.6 | 1.5 |
| | Rota Island: Summit .................. | 14 07 30 | 145 13 04 | ........ | ........ | ........ | ........ |
| | Tinian Island: Sunharon village....... | 14 59 22 | 145 36 20 | ........ | ........ | ........ | ........ |
| | Saipan Island: Magicienne Bay, landing ............................... | 15 08 30 | 145 43 55 | ........ | ........ | ........ | ........ |
| | Tanapag Hbr., Garapag. | 15 17 10 | 145 42 50 | 7 00 | 0 50 | 2.0 | 1.1 |
| | Anataxan Island: Center.............. | 16 20 00 | 145 39 00 | ........ | ........ | ........ | ........ |
| | Sariguan Island: Center............... | 16 41 00 | 145 47 00 | ........ | ........ | ........ | ........ |
| | Guguan Island: Center ................ | 17 17 00 | 145 57 00 | ........ | ........ | ........ | ........ |
| | Alamaguan Island: Center ............ | 17 36 00 | 145 55 00 | ........ | ........ | ........ | ........ |
| | Pagan Island: SW. pt................. | 18 04 00 | 145 52 00 | ........ | ........ | ........ | ........ |
| | Agrigan Island: SE. pt................ | 18 46 20 | 145 41 45 | ........ | ........ | ........ | ........ |
| | Asuncion Island: Crater, 2,600 ft ...... | 19 45 00 | 145 30 00 | ........ | ........ | ........ | ........ |
| | Urracas Islands: Largest islet.......... | 20 00 00 | 145 21 00 | ........ | ........ | ........ | ........ |
| | Farralon de Pajaros: S. end ........... | 20 32 54 | 144 54 00 | ........ | ........ | ........ | ........ |

MARITIME POSITIONS AND TIDAL DATA.

**ISLANDS OF THE PACIFIC—Continued.**

| Coast. | Place. | Lat. N. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Wake Island: Obs. spot | 19 15 00 | 166 31 30 | | | | |
| | Gaspar Rico Reef: N. clump of rocks | 14 41 00 | 168 54 28 | | | | |
| | Johnston or Cornwallis Islands: Flag-staff on W. island | 16 44 48 | Long. W. 169 32 24 | | | | |
| | Clipperton Island: Center | 10 17 00 | 109 13 00 | | | | |
| Hawaiian Islands. | Hawaii Island: Hilo, Kanaha Pt. light | 19 46 14 | 155 05 31 | 3 09 | 9 06 | 2.3 | 1.3 |
| | Kawaihae light | 20 03 00 | 155 48 00 | | | | |
| | Kealakeakua Bay light | 19 28 00 | 155 55 00 | 2 20 | 8 10 | 1.6 | 0.9 |
| | Kailua, stone church | 19 38 26 | 156 00 15 | | | | |
| | Kahoolawe Island: Summit | 20 33 39 | 156 35 04 | | | | |
| | Maui Island: Kanahena Pt. light | 20 36 00 | 156 26 00 | | | | |
| | Lahaina light | 20 52 00 | 156 35 00 | 3 32 | 9 58 | 2.2 | 1.2 |
| | Molokai Island: Light-house | 21 06 17 | 157 18 32 | 2 38 | 8 56 | 2.1 | 1.1 |
| | Oahu Island: E. pt. Makapuu station | 21 18 16 | 157 39 07 | | | | |
| | Diamond Head | 21 15 08 | 157 48 44 | | | | |
| | Honolulu, Tr. of V. Obs | 21 17 57 | 157 51 34 | | | | |
| | Honolulu, Reef light | 21 17 55 | 157 51 54 | 3 46 | 9 59 | 1.5 | 0.8 |
| | Kauai Island: Hanalei, Black Head | 22 12 51 | 159 30 47 | | | | |
| | Waimea, stone church | 21 57 17 | 159 40 08 | 4 00 | 10 20 | 2.0 | 1.1 |
| | Bird Island: Center | 23 05 50 | 161 58 17 | | | | |
| | Necker Island: Center | 23 35 18 | 164 40 47 | | | | |
| | French Frigate Shoal: Islet (120 ft.) | 23 46 00 | 166 17 57 | | | | |
| | Gardiner Island: Center | 25 00 40 | 168 00 52 | | | | |
| | Maro Reef: NW. pt | 25 31 00 | 170 39 20 | | | | |
| | Laysan Island: Light-house | 25 48 00 | 171 44 00 | | | | |
| | Lisiansky Island: Light-house | 26 00 00 | 173 57 00 | | | | |
| | Pearl and Hermes Reef: NE. extreme | 27 56 30 | 175 46 00 | | | | |
| | Midway Islands: N. end Sand Islet | 28 13 15 | 177 21 30 | 3 30 | 9 45 | 1.1 | 0.6 |
| | Ocean Island: Sand Islet | 28 24 45 | 178 27 45 | | | | |
| | Marcus Island: Center | 24 14 00 | Long. E. 154 00 00 | | | | |
| | Bonin Is., Parrys Group: N. rock | 27 45 00 | 142 06 53 | | | | |
| | Kater Island: N. rock | 27 31 00 | 142 11 53 | | | | |
| | Peel Island: Port Lloyd, observatory | 27 05 37 | 142 11 23 | 6 10 | 0 00 | 2.4 | 1.4 |
| | Volcano Is., San Alessandro or North Island: Center | 25 14 00 | 141 11 00 | | | | |
| | Sulphur Island | 24 48 00 | 141 13 00 | | | | |
| | San Augustine Island: Center | 24 14 00 | 141 20 00 | | | | |
| | Rosario Island: Center, 148 ft | 27 15 32 | 140 50 28 | | | | |
| | Douglass Rocks: Center | 20 30 00 | 136 10 00 | | | | |
| | Borodino Islands: Center of N. island | 25 59 38 | 131 19 30 | | | | |
| | Center of S. island | 25 52 45 | 131 12 17 | | | | |
| | Rasa Island: Center | 24 27 00 | 131 01 50 | | | | |
| Marquesas Islands. | | Lat. S. | Long. W. | | | | |
| | Fatu Hiva Island: S. pt | 10 32 00 | 138 39 20 | | | | |
| | Motane Island: SSE. pt | 10 01 40 | 138 48 30 | | | | |
| | Tahuata Island: Port Resolution, watering place | 9 56 00 | 139 09 00 | 2 30 | 8 45 | 3.1 | 1.9 |
| | Hiva-Oa Island: C. Balguerie | 9 45 00 | 138 47 40 | | | | |
| | Fatu Huku Island: Center | 9 27 30 | 138 55 10 | | | | |
| | Roa Poua Island: Obelisk Islet | 9 29 30 | 140 04 45 | | | | |
| | Nuka-Hiva Island: Port Tai-o-hae light | 8 55 13 | 140 04 00 | 3 50 | 10 05 | 3.5 | 2.1 |
| | Hiaou Island: S. pt | 8 03 30 | 140 44 00 | | | | |
| | Motu-ili Island: Summit, 130 ft | 8 44 00 | 140 38 30 | | | | |
| | Ua-Huka or Ua-Una Island: N. pt | 8 54 00 | 139 33 30 | | | | |
| | Fetouhouhou Island: NE. pt | 7 55 00 | 140 34 40 | | | | |
| | Caroline Islands: Solar Eclipse Transit Pier | 10 00 01 | 150 14 30 | 4 00 | 10 14 | 1.1 | 0.7 |
| | Vostok Island: Center | 10 06 00 | 152 23 00 | | | | |
| | Flint Island: S. extremity | 11 25 23 | 151 48 34 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

**ISLANDS OF THE PACIFIC—Continued.**

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Malden Island: Flagstaff, W. side ..... | 4 03 00 | 155 01 00 | ........ | ........ | ....... | ...... |
| | Starbuck Island: Flagstaff, W. side .... | 5 37 00 | 155 56 00 | ........ | ........ | ....... | ...... |
| | Penrhyn or Tongarewa Island: NNW.pt. | 8 55 15 | 158 07 00 | 6 00 | 12 15 | 1.5 | 0.9 |
| | Jarvis Island: Center ................. | 0 22 33 | 159 54 11 | ........ | ........ | ....... | ...... |
| | Reirson Island: Church ............... | 10 02 00 | 161 05 30 | ........ | ........ | ....... | ...... |
| | Humphrey Island: N. pt............... | 10 20 30 | 161 01 12 | ........ | ........ | ....... | ...... |
| | Union or Tokelau Islands: Spot N. of Fakaofu or Bowditch Islet............ | 9 23 02 | 171 14 46 | 6 00 | 12 13 | 2.4 | 1.4 |
| | Union or Tokelau Islands: Nuku-nono, or SE. island, Duke of Clarence I.... | 9 13 06 | 171 44 40 | ........ | | ....... | ...... |
| | Union or Tokelau Islands: Clump on S. island, Oatafu or Duke of York I... | 8 39 40 | 172 28 10 | ........ | ........ | ....... | ...... |
| Phœnix Is. | Canton or Mary Island: N. pt.......... | 2 44 25 | 171 45 29 | ........ | ........ | ....... | ...... |
| Phœnix Is. | Enderbury Island: W. pt ............... | 3 08 30 | 171 10 00 | 5 00 | 11 15 | 4.6 | 2.7 |
| Phœnix Is. | Phœnix Island, N. pt................. | 3 42 28 | 170 42 37 | ........ | ........ | ....... | ...... |
| Phœnix Is. | Birneys Island: S. pt ................ | 3 34 15 | 171 32 07 | ........ | ........ | ....... | ...... |
| Phœnix Is. | Gardners Island: Center .............. | 4 37 42 | 174 40 18 | ........ | ........ | ....... | ...... |
| Phœnix Is. | McKean Island: Center............... | 3 35 10 | 174 17 26 | ........ | ........ | ....... | ...... |
| Phœnix Is. | Hulls Island: W. pt .................. | 4 30 95 | 172 13 28 | ........ | ........ | ....... | ...... |
| | | | Long. E. | | | | |
| Ellice Islands. | Mukulaelae or Mitchells Island: S. pt... | 9 18 00 | 179 50 00 | ........ | ........ | ....... | ...... |
| Ellice Islands. | Funafuti or Ellice Island: E. pt ....... | 8 25 19 | 179 07 25 | ........ | ........ | ....... | ...... |
| Ellice Islands. | Nukufetau or De Peysters Island: S. pt. | 8 04 02 | 178 28 51 | ........ | ........ | ....... | ...... |
| Ellice Islands. | Vaitupu Island: S. end ............... | 7 32 00 | 178 41 01 | ........ | ........ | ....... | ...... |
| Ellice Islands. | Nui or Netherland Island: S. pt........ | 7 15 45 | 177 16 50 | ........ | ........ | ....... | ...... |
| Ellice Islands. | Nauomaga Island: Center ............. | 6 12 00 | 176 16 30 | ........ | ........ | ....... | ...... |
| Ellice Islands. | Niutao Island: Church................ | 6 06 00 | 177 20 01 | ........ | ........ | ....... | ...... |
| Ellice Islands. | Nanomea Island: Center .............. | 5 39 00 | 176 06 15 | ........ | ........ | ....... | ...... |
| | Ocean or Paanopa Island: Center (appx). | 0 52 00 | 169 35 00 | ........ | ........ | ....... | ...... |
| | Pleasant Island: Center............... | 0 25 00 | 167 05 00 | ........ | ........ | ....... | ...... |
| | Indispensable Reefs: S. pt. of S. reef... | 12 50 15 | 160 26 00 | ........ | ........ | ....... | ...... |
| | Rennel Island: SE. extreme........... | 11 52 15 | 160 40 15 | ........ | ........ | ....... | ...... |
| | W. end.................. | 11 33 45 | 159 55 00 | ........ | ........ | ....... | ...... |
| Solomon Islands. | San Christoval Island: Point Wanga-laha ..................... | 10 17 32 | 161 33 30 | 6 45 | 0 33 | 3.3 | 2.0 |
| Solomon Islands. | Guadalcanar Island: Wanderer Bay, mouth of Boyd Creek............... | 9 41 47 | 159 39 30 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Florida Island: Mboli Harbor, Tree Islet. | 9 01 30 | 160 27 20 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Malaita Island: Village, Mary I., Port Adam ..................... | 9 30 00 | 161 27 40 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Stewart Islands: Largest islet.......... | 8 23 00 | 162 58 15 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Isabel Island: N. side of Cockatoo Islet. | 8 30 50 | 159 38 20 | 5 00 | 11 15 | 3.5 | 2.1 |
| Solomon Islands. | Gizo or Shark Island: N. point village.. | 8 05 40 | 156 50 15 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Choiseul Island: Choiseul Bay en-trance ..................... | 6 42 40 | 156 23 16 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Treasury Islands: Observation Islet.... | 7 24 30 | 155 34 00 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Bougainville Island: Hiisker Pt., Ga-zelle Harbor ................... | 6 35 00 | 155 05 00 | 12 00 | 5 47 | 2.7 | 1.6 |
| Solomon Islands. | Buka Island: Cape North ............. | 5 00 00 | 154 35 00 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Lord Howe Group: Center, small SW. islet.............. | 5 38 00 | 159 21 00 | ........ | ........ | ....... | ...... |
| Solomon Islands. | Center, small NE. islet............. | 5 18 00 | 159 34 00 | ........ | ........ | ....... | ...... |
| Solomon Islands. | NW. pt. of Ham-mond I.......... | 5 18 00 | 159 17 00 | ........ | ........ | ....... | ...... |
| | New Britain, Blanche Bay: Matupi I. N. pt ..................... | 4 14 12 | 152 11 35 | 9 00 | 2 45 | 2.1 | 1.3 |
| | Duke of York Island: Makada Har-bor, Spit Pt ................... | 4 06 25 | 152 06 15 | ........ | ........ | ....... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

**ISLANDS OF THE PACIFIC—Continued.**

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | New Ireland: Carteret Harbor, Cocoa-nut I | 4 41 26 | 152 42 25 | ........ | ........ | ........ | ........ |
| | Katharine Haven | 3 11 00 | 151 35 30 | ........ | ........ | ........ | ........ |
| | Holz Haven, E. side | 2 47 30 | 150 57 35 | 2 50 | 9 03 | 2.4 | 1.4 |
| | New Hanover Island: Water Haven, creek mouth | 2 33 43 | 150 04 33 | ........ | ........ | ........ | ........ |
| | North Haven anchorage | 2 26 30 | 149 55 36 | 2 30 | 8 43 | 2.4 | 1.4 |
| | St. Matthias Island: SW. extreme | 1 35 00 | 149 37 00 | ........ | ........ | ........ | ........ |
| **Admiralty Is.** | Admiralty Island: Nares Harbor, obs. islet | 1 55 10 | 146 40 56 | ........ | ........ | ........ | ........ |
| | St. Andrew Island: Violet Islet, 60 ft | 2 25 40 | 147 28 35 | ........ | ........ | ........ | ........ |
| | Jesus Maria Island: SE. pt | 2 22.00 | 147 55 00 | ........ | ........ | ........ | ........ |
| | Commerson Island: Center of largest islet | 0 45 00 | 145 17 00 | | | | ........ |
| | Anchorite Island: N. pt | 0 53 15 | 145 33 04 | ........ | ........ | ........ | ........ |
| | Hermit or Loaf Island: Pemé Islet | 1 28 00 | 145 08 00 | ........ | ........ | ........ | ........ |
| | Purdy Island: Mole Islet | 2 51 00 | 146 15 00 | ........ | ........ | ........ | ........ |
| **New Guinea Island.** | Point d'Urville: extreme | 1 25 40 | 135 28 12 | ........ | ........ | ........ | ........ |
| | Drei Cap Peninsula: Wass Islet | 2 44 00 | 132 04 00 | ........ | ........ | ........ | ........ |
| | Triton Bay: Fort Dubus, Dubus Haven | 3 47 00 | 134 06 00 | 0 55 | 7 08 | 7.3 | 4.3 |
| | Cape Walsche: Extreme | 8 22 00 | 137 40 00 | ........ | ........ | ........ | ........ |
| | Fly River: Free Islet, S. pt | 8 41 00 | 143 36 04 | ........ | ........ | ........ | ........ |
| | Port Moresby: N. end of Jane I | 9 25 30 | 147 07 04 | 8 50 | 2 38 | 8.0 | 4.8 |
| | Cape Rodney: Extreme | 10 14 30 | 148 30 30 | ........ | ........ | ........ | ........ |
| | South Cape: S. pt. Su Au I | 10 43 35 | 150 14 20 | 9 15 | 3 00 | 8.1 | 4.8 |
| | Hayter Island: W. end | 10 37 00 | 150 40 34 | 8 25 | 2 12 | 5.8 | 3.4 |
| | Cape Cretin: Cretin Islets | 6 43 00 | 147 53 20 | ........ | ........ | ........ | ........ |
| **Louislade Arch.** | Trobriand Islands: NE. pt Cape Denis | 8 24 00 | 151 01 24 | 4 45 | 10 58 | 3.0 | 1.8 |
| | Woodlark Islands: N. pt | 9 03 30 | 152 47 00 | 7 05 | 0 53 | 4.2 | 2.5 |
| | D'Entrecasteaux Is.: Ferguson I., SW. extreme | 9 38 00 | 150 30 00 | | | | ........ |
| | Well Island, E. pt | 9 41 00 | 150 58 00 | | | | |
| | Normanby I., obs. islet | 9 43 53 | 150 44 43 | ........ | ........ | ........ | ........ |
| | St. Aignan Island: Summit | 10 42 00 | 152 42 04 | ........ | ........ | ........ | ........ |
| | Renard Islands: W. pt | 10 52 40 | 152 47 12 | ........ | ........ | ........ | ........ |
| | Rossel Island: E. pt | 11 23 25 | 154 08 00 | ........ | ........ | ........ | ........ |
| | Adèle Island: S. extreme | 11 29 10 | 154 25 14 | ........ | ........ | ........ | ........ |
| **Coral Sea Arch.** | Coringa Islands: Chilcott Islet | 16 50 00 | 149 58 00 | ........ | ........ | ........ | ........ |
| | Herald Cays: NE. Cay | 16 55 50 | 149 11 54 | ........ | ........ | ........ | ........ |
| | Tregosse Islands; S. islet | 17 43 00 | 150 42 04 | ........ | ........ | ........ | ........ |
| | Lhou Reef: Observation Cay | 17 07 20 | 152 06 20 | ........ | ........ | ........ | ........ |
| | Mellish Reef: Cay beacon | 17 24 39 | 155 52 24 | ........ | ........ | ........ | ........ |
| | Bampton Island | 19 08 00 | 158 40 00 | ........ | ........ | ........ | ........ |
| | Renard Island: Center | 19 14 00 | 159 00 00 | ........ | ........ | ........ | ........ |
| | Wreck Reef: Bird Islet | 22 10 30 | 155 28 24 | ........ | ........ | ........ | ........ |
| | Cato Island: Center | 23 15 02 | 155 33 04 | ........ | ........ | ........ | ........ |
| **Santa Cruz Is.** | Duff or Wilson Group: N. island | 9 48 00 | 166 53 15 | ........ | ........ | ........ | ........ |
| | Matema or Swallow Group: Nimanu Islet | 10 21 00 | 166 17 15 | ........ | ........ | ........ | ........ |
| | Tinakula Island: Summit, 2,200 ft | 10 23 30 | 165 47 30 | ........ | ........ | ........ | ........ |
| | Nitendi Island: NE. pt., Cape Byron | 10 40 00 | 166 00 30 | ........ | ........ | ........ | ........ |
| | Tapua Island: Basilisk Harbor, S. pt. of entrance | 11 17 30 | 166 32 14 | ........ | ........ | ........ | ........ |
| | Vanikoro: Ocili village | 11 40 24 | 166 57 45 | 4 50 | 11 05 | 3.8 | 2.3 |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### ISLANDS OF THE PACIFIC—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **New Hebrides Islands.** | Torres or Ababa Island: Hayter Bay, Middle I | 13 15 00 | 166 33 00 | | | | |
| | Vanua Lava Island: Port Patterson, Nusa Pt | 13 48 00 | 167 30 31 | 6 40 | 0 30 | 3.8 | 2.3 |
| | Santa Maria Island: Lasolara Anchorage | 14 11 00 | 167 30 00 | | | | |
| | Aurora Island: Laka-rere | 14 58 00 | 168 02 00 | | | | |
| | Mallicollo Island: Port Sandwich, pt. on E. side | 16 26 00 | 167 47 15 | 4 38 | 10 50 | 3.8 | 1.9 |
| | Vaté or Sandwich Island: Havannah Harbor, Matapou Bay flagstaff | 17 44 58 | 168 18 50 | 5 15 | 11 27 | 3.0 | 1.8 |
| | Erromango Island: Dillon Bay, Pt. Williams | 18 47 30 | 168 58 00 | | | | |
| | Tanna Island: Port Resolution, Mission. | 19 31 17 | 169 27 30 | | | | |
| | Erronan or Futuna Island: NW. pt | 19 31 20 | 170 11 15 | | | | |
| | Aneityum Island: Port Anatom, Sand Islet | 20 15 17 | 169 44 45 | 5 10 | 11 23 | 3.1 | 1.9 |
| | Matthew Island: Peak, 465 feet | 22 20 12 | 171 20 30 | | | | |
| | Hunter Island: Peak, 974 feet | 22 24 02 | 172 05 15 | | | | |
| | Walpole Island: S. pt | 22 38 07 | 168 56 45 | | | | |
| | Mitre Island: Center | 11 55 00 | 170 10 00 | | | | |
| | Rotumah Island: Epipigi Peak | 12 30 10 | 177 07 15 | 6 15 | 0 00 | 4.2 | 2.5 |
| **Fiji Islands.** | Kandavu Island: N. rock Astrolabe Reef light | 18 38 15 | 178 32 15 | | | | |
| | Mt. Washington, N. peak | 19 07 09 | 177 57 09 | | | | |
| | N'galoa Harbor, outer beacon | 19 05 30 | 178 10 24 | 6 40 | 0 25 | 4.0 | 2.4 |
| | Vatu Lele Island: S. pt | 18 36 00 | 177 38 00 | | | | |
| | Ovalau Island: Levuka light-house | 17 40 45 | 178 49 00 | | | | |
| | Viti Levu Island: Summit of Malolo Islet | 17 44 45 | 177 09 00 | | | | |
| | Suva Harbor, low light | 18 06 50 | 178 24 40 | 6 30 | 0 15 | 3.6 | 2.2 |
| | Mbega or Mbengha Island: Swan Harbor, Leaven Pt | 18 22 00 | 178 06 53 | | | | |
| | Matuku Island: N. side of Matuku entrance | 19 09 38 | 179 44 27 | | | | |
| | Moala Island: Rocks off N. pt | 18 32 49 | 179 56 25 | | | | |
| | Ngau Island: Herald Bay, E. side | 17 59 32 | 179 14 08 | | | | |
| | Wakaya Island: Rocky Peak | 17 37 11 | 178 59 29 | | | | |
| | Makongai Island: Dilliendreti Peak | 17 27 14 | 178 57 46 | | | | |
| | Goro Island: NW. pt | 17 15 21 | 179 20 44 | | | | |
| | Vanua Levu Island: Mount Dana | 16 42 01 | 178 54 15 | | | | |
| | Nandi, observation islet | 16 57 53 | 178 48 32 | | | | |
| | Savu Savu Pt.; extreme | 16 49 19 | 179 16 08 | 6 00 | 12 13 | 4.3 | 2.6 |
| | | | Long. W. | | | | |
| | NE. Pt | 16 08 00 | 179 58 46 | | | | |
| | Taoiuni Island: Somu-Somu town | 16 46 00 | 179 51 00 | | | | |
| | Thikombia Island: E. hummock | 15 44 45 | 179 54 26 | | | | |
| | Naitamba Island: Center | 17 03 00 | 179 17 00 | | | | |
| | Vatu Vara Island: N. end, summit | 17 25 33 | 179 32 17 | | | | |
| | Kanathea Island: S. pt | 17 17 20 | 179 10 00 | | | | |
| | Vanua Mbalavu Island: NW. pt | 17 10 00 | 179 05 45 | | | | |
| | Mango Island: Pier end | 17 25 26 | 179 10 33 | 6 10 | 0 00 | 3.1 | 1.9 |
| | Thithia Island: Highest peak | 17 44 12 | 179 19 49 | | | | |
| | Tuvutha Island: Peak | 17 39 33 | 178 50 27 | | | | |
| | Naian Island: Summit, 580 ft | 17 59 00 | 179 04 00 | | | | |
| | Lakemba Island: Kendi Pt | 18 14 10 | 178 52 00 | | | | |
| | Oneata Island: Summit of Loa I | 18 25 46 | 178 27 04 | | | | |
| | Mothe Island: Summit | 18 38 56 | 178 30 54 | | | | |
| | Mamuka Island: Center, 260 feet | 18 46 00 | 178 44 00 | | | | |

MARITIME POSITIONS AND TIDAL DATA.

**ISLANDS OF THE PACIFIC—Continued.**

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Fiji Islands.** | Kambara Island: Highest peak......... | 18 56 15 | 178 59 05 | ........ | ........ | ...... | ...... |
| | Totoya Island: Black Rock Bay, W. side | 18 58 57 | 179 52 58 | 6 35 | 0 20 | 3. 5 | 2. 1 |
| | Fulanga Island: W. bluff............... | 19 03 00 | 178 47 25 | ........ | ........ | ...... | ...... |
| | Ongea Levu Island: Center............. | 19 04 00 | 178 33 25 | ........ | ........ | ...... | ...... |
| | Vatoa or Turtle Island: Hummock..... | 19 49 11 | 178 13 38 | 6 10 | 0 00 | 3. 1 | 1. 9 |
| | Ono Islands: Peak..................... | 20 39 10 | 178 43 27 | ........ | ........ | ...... | ...... |
| | Michaeloff Island: Center............. | 21 00 09 | 178 44 03 | ........ | ........ | ...... | ...... |
| | Simonoff Island: Center ............. | 21 01 39 | 178 49 47 | ........ | ........ | ...... | ...... |
| | Fatuna or Horne Island: Mt. Schouten. | 14 14 20 | 178 06 45 | ........ | ........ | ...... | ...... |
| | Uea or Wallis Island: Fenua-fu Islet.... | 13 23 35 | 176 11 47 | 6 40 | 0 28 | 4. 4 | 2. 7 |
| | Niua-fu or Good Hope Island: NW. extreme ...................... | 15 34 00· | 175 40 40 | ........ | ........ | ...... | ...... |
| | Keppel Island: Center ................ | 15 52 00 | 173 52 00 | ........ | ........ | ...... | ...... |
| | Boscawen Island: Center.............. | 15 58 00 | 173 52 00 | ........ | ........ | ...... | ...... |
| **Samoan Is.** | Savaii Island: Paluale village........... | 13 45 00 | 172 17 00 | ........ | ........ | ...... | ...... |
| | Upulo Is.: Apia Harbor, obs. spot ..... | 13 48 56 | 171 44 56 | 6 25 | 0 13 | . 3. 1 | 1. 9 |
| | Tutuila Island: Pago-Pago, obs. pt...... | 14 18 06 | 170 42 14 | 7 00 | 0 45 | 2. 7 | 1. 6 |
| | Manua Island: Village, NW. side ...... | 14 19 00 | 169 32 00 | 6 00 | 12 13 | 4. 6 | 2. 7 |
| | Rose Island: Center.................. | 14 32 00 | 168 09 00 | ........ | ........ | ...... | ...... |
| | Niue or Savage Island: S. pt........... | 19 10 00 | 169 50 00 | ........ | ........ | ...... | ...... |
| | Danger, or Bernardo, Is.: Middle rock . | 10 52 47 | 165 51 30 | ........ | ........ | ...... | ...... |
| | Suwarrow or Souwaroff Island: Cocoa-nut Islet ...... | 13 14 30 | 163 04 10 | 3 10 | 9 23 | 2. 4 | 1. 4 |
| | Palmerston Islands: W. islet........... | 18 05 50 | 163 10 00 | ........ | ........ | ...... | ...... |
| | Scilly Islands: E. islet ............... | 16 28 00 | 154 30 00 | ........ | ........ | ...... | ...... |
| | Bellingshausen Island: Center......... | 15 48 00 | 154 31 00 | ........ | ........ | ...... | ...... |
| | Mopelia (Lord Howe) Island: Center.. | 16 52 00 | 154 00 00 | ........ | ........ | ...... | ...... |
| **Society Islands.** | Maitea Island: Summit ............... | 17 53 00 | 148 05 00 | ........ | ........ | ...... | ...... |
| | Tahiti Island: Light-house............. | 17 29 10 | 149 29 00 | 12 00 | 5 48 | 1. 0 | 0. 6 |
| | Tubuai-Manu or Maia-iti I.: NW. pass. | 17 36 39 | 150 36 56 | ........ | ........ | ...... | ...... |
| | Eimeo Island: Talu Hbr., Vincennes Pt. | 17 29 23 | 149 50 30 | ........ | ........ | ...... | ...... |
| | Huaheine Island: Light-house.......... | 16 42 30 | 151 01 28 | ........ | ........ | ...... | ...... |
| | Ulietea Island: Regent Pt............. | 16 50 00 | 151 27 21 | ........ | ........ | ...... | ...... |
| | Tahoa Island: Center................. | 16 35 00 | 151 35 00 | ........ | ........ | ...... | ...... |
| | Bola-Bola Island: Otea-Vanua village.. | 16 31 35 | 151 46 00 | 12 10 | 6 00 | 1. 4 | 0. 8 |
| | Tubai or Motu-iti Island: N. pt. of reef.. | 16 11 00 | 151 48 00 | ........ | ........ | ...... | ...... |
| | Marua or Maupili Island: Center ...... | 16 26 00 | 152 12 00 | ........ | ........ | ...... | ...... |
| **Tuamotu Archipelago.** | Ducie Island: NE. entrance ........... | 24 40 20 | 124 48 00 | ........ | ........ | ...... | ...... |
| | Pitcairn Island: Village................ | 25 03 50 | 130 08 30 | ........ | ........ | ...... | ...... |
| | Henderson or Elizabeth Island: Center. | 24 21 20 | 128 19 00 | ........ | ........ | ...... | ...... |
| | Oeno Island: N. pt.................... | 24 01 20 | 130 41 00 | ........ | ........ | ...... | ...... |
| | Mangareva or Gambier Island: Flagstaff | 23 07 36 | 134 57 54 | 1 50 | 8 03 | 2. 4 | 1. 4 |
| | Marutea or Lord Hood Island: Center.. | 21 31 30 | 135 33 05 | ........ | ........ | ...... | ...... |
| | Maria or Moerenhout Island: Center... | 22 01 00 | 136 10 15 | ........ | ........ | ...... | ...... |
| | Vahanga Island: W. pt................. | 21 20 00 | 136 38 53 | ........ | ........ | ...... | ...... |
| | Morane or Cadmus Island: Center..... | 23 07 50 | 137 06 15 | ........ | ........ | ...... | ...... |
| | Tureia or Carysfort Island: E. pt ...... | 20 46 20 | 138 27 45 | ........ | ........ | ...... | ...... |
| | Mururoa or Osnabrug Island: Obs. spot. | 21 50 00 | 138 56 30 | ........ | ........ | ...... | ...... |
| | Tematangi or Bligh Island: N. pt...... | 21 38 00 | 140 38 45 | ........ | ........ | ...... | ...... |
| | Nukutipipi: SW. pt.................... | 20 43 00 | 143 03 15 | ........ | ........ | ...... | ...... |
| | Hereheretue or St. Paul Island: Center. | 19 53 17 | 144 57 00 | ........ | ........ | ...... | ...... |
| | Vanavana or Barrow Island: Center ... | 20 46 07 | 139 08 45 | ........ | ........ | ...... | ...... |
| | Nukutavake or Queen Charlotte I.: N. pt | 19 16 30 | 138 48 30 | ........ | ........ | ...... | ...... |
| | Reao or Clermont Tonnere Island: NW. point ...................... | 18 29 00 | 136 26 30 | ........ | ........ | ...... | ...... |
| | Puka-ruha or Serles Island: NW. pt.... | 18 16 00 | 137 03 30 | ........ | ........ | ...... | ...... |
| | Vahitahi Island: W. pt................ | 18 43 30 | 138 53 15 | ........ | ........ | ...... | ...... |
| | Ahunui or Byam Martin Island: NW. pt. | 19 37 00 | 140 15 45 | ........ | ........ | ...... | ...... |
| | Pinaki or Whitsunday Island: E. pt ... | 19 25 00 | 138 40 45 | ........ | ........ | ...... | ...... |
| | Tatakoto or Clerke Island: Flagstaff on western coast...................... | 17 19 30 | 138 26 26 | ........ | ........ | ...... | ...... |

### MARITIME POSITIONS AND TIDAL DATA.

#### ISLANDS OF THE PACIFIC—Continued.

| Coast. | Place. | Lat. S. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| **Tuamotu Archipelago.** | Hao or La Harpe Island: NW. pass .... | 18 05 20 | 140 59 30 | 2 40 | 8 55 | 2.4 | 1.4 |
| | Paraoa or Glocester Island: Center .... | 19 08 45 | 141 41 10 | ........ | ........ | ...... | ...... |
| | Ravahere Island: S. pt................ | 18 18 30 | 142 11 31 | ........ | ........ | ...... | ...... |
| | Reitoru or Bird Island: N. beach ...... | 17 49 35 | 143 05 23 | ........ | ........ | ...... | ...... |
| | Hikueru or Melville Island, E. pt...... | 17 35 28 | 142 35 16 | ........ | ........ | ...... | ...... |
| | Tauere Island: NW. pt ................ | 17 20 30 | 141 29 43 | ........ | ........ | ...... | ...... |
| | Puka-puka Island: E. pt .............. | 14 49 00 | 138 46 45 | ........ | ........ | ...... | ...... |
| | Napuka Island: W. pt................. | 14 12 00 | 141 15 37 | ........ | ........ | ...... | ...... |
| | Angatau or Araktcheff Island: W. pt ... | 15 50 00 | 140 53 35 | ........ | ........ | ...... | ...... |
| | Tukume or Wolkonsky Island: NW. pt. | 15 44 20 | 142 08 40 | ........ | ........ | ...... | ...... |
| | Tuanske Island: NW. pt.............. | 16 39 10 | 144 14 45 | ........ | ........ | ...... | ...... |
| | Nihiru Island (Tuanake): SW. pt ..... | 16 44 29 | 142 53 34 | ........ | ........ | ...... | ...... |
| | Anaa Island: Islet in N. pass.......... | 17 20 20 | 145 30 54 | ........ | ........ | ...... | ...... |
| | Tepoto Island: N. pt.................. | 16 47 49 | 144 17 18 | ........ | ........ | ...... | ...... |
| | Haraiki or Crocker Island: SW. pt .... | 17 28 41 | 143 31 17 | ........ | ........ | ...... | ...... |
| | Makemo or Phillips Island: W. pass... | 16 26 09 | 143 57 59 | ........ | ........ | ...... | ...... |
| | Fakarana or Wittgenstein Island: SE. pass ...................... | 16 31 00 | 145 22 45 | ........ | ........ | ...... | ...... |
| | Taiaro or Kings I.: Middle of W. shore. | 15 43 15 | 144 38 34 | ........ | ........ | ...... | ...... |
| | Aratika Island: E. pt................. | 15 30 00 | 145 24 45 | ........ | ........ | ...... | ...... |
| | Toau or Elizabeth Island: Amyot Bay. | 15 50 00 | 146 02 45 | ........ | ........ | ...... | ...... |
| | Takapoto Island: S. pt............... | 14 43 00 | 145 11 00 | ........ | ........ | ...... | ...... |
| | Aheu Island: Lagoon Entrance........ | 14 29 10 | 146 20 00 | ........ | ........ | ...... | ...... |
| | Rangiroa Island: E. pt................ | 15 14 30 | 147 11 00 | 4 30 | 10 43 | 2.1 | 1.3 |
| | Makatea Island: W. pt................ | 15 50 30 | 148 15 00 | ........ | ........ | ...... | ...... |
| | Matahiva Island: W. pt.............. | 14 53 00 | 148 39 45 | ........ | ........ | ...... | ...... |
| | Juan Fernandez Island: Fort S. Juan Batista......................... | 33 37 36 | 78 50 02 | ........ | ........ | ...... | ...... |
| | Mas-afuera Island: Summit, 4,000 ft ... | 33 46 00 | 80 46 00 | ........ | ........ | ...... | ...... |
| | St. Ambrose Island: N. part creek ..... | 26 18 07 | 79 54 56 | ........ | ........ | ...... | ...... |
| | St. Felix Island: Center.............. | 26 16 00 | 80 06 56 | ........ | ........ | ...... | ...... |
| | Sala y Gomez: NW. pt................ | 26 27 41 | 105 28 00 | 4 00 | 10 15 | 3.3 | 2.0 |
| | Easter Island: Cooks Bay, mission..... | 27 10 00 | 109 26 00 | 0 40 | 6 53 | 2.8 | 1.7 |
| | Rapa or Oparo Island: Tauna Islet..... | 27 35 46 | 144 17 20 | 0 10 | 6 25 | 2.4 | 1.4 |
| | Bass Islets (Morotiri): SE. islet, 344 ft. | 27 55 30 | 143 28 21 | ........ | ........ | ...... | ...... |
| | Tubuai or Austral Is., Vavitoa I.: Center. | 23 55 00 | 147 48 00 | ........ | ........ | ...... | ...... |
| | Tubuai I.: Flag staff, N. side.... | 23 21 45 | 149 35 35 | 3 00 | 9 13 | 2.4 | 1.4 |
| | Rurutu I.: N. pt .. | 22 29 00 | 151 23 41 | ........ | ........ | ...... | ...... |
| | Rimitara I.: Center............. | 22 45 00 | 152 55 00 | ........ | ........ | ...... | ...... |
| **Cook Islands.** | Hull Island: NW. pt................. | 21 47 00 | 154 51 00 | ........ | ........ | ...... | ...... |
| | Mangaia Island: Center.............. | 21 49 00 | 157 56 00 | ........ | ........ | ...... | ...... |
| | Rarotonga Island: NW. pt ............ | 21 11 35 | 159 47 00 | 6 00 | 12 15 | 2.7 | 1.7 |
| | Mauki or Parry Island: Center ........ | 20 17 00 | 157 23 00 | ........ | ........ | ...... | ...... |
| | Mitiero Island: Center............... | 20 01 00 | 157 34 00 | ........ | ........ | ...... | ...... |
| | Vatiu or Atiu Island: Center .......... | 20 04 00 | 158 08 00 | ........ | ........ | ...... | ...... |
| | Hervey Islets: Center................ | 19 18 00 | 158 54 00 | ........ | ........ | ...... | ...... |
| | Aitutaki Island: Center .............. | 18 54 00 | 159 32 00 | ........ | ........ | ...... | ...... |
| **Tonga Is.** | Vavau Island: Port Valdes, Sandy Pt.. | 18 39 02 | 174 01 00 | 6 20 | 0 10 | 3.8 | 2.3 |
| | Kao Island: Summit, 5,000 ft.......... | 19 41 35 | 174 59 50 | ........ | ........ | ...... | ...... |
| | Tofua Island: Summit, 2,800 ft ........ | 19 45 00 | 175 03 00 | ........ | ........ | ...... | ...... |
| | Tongatabu Island: Light-house........ | 21 08 00 | 175 12 00 | 6 20 | 0 10 | 3.8 | 2.3 |
| | Minerva Reefs, N. Minerva: NE. side.. | 23 37 06 | 178 55 45 | 7 50 | 1 35 | 5.5 | 3.3 |
| | S. Minerva: S. side of entrance | 23 55 00 | 179 07 45 | ........ | ........ | ...... | ...... |
| | Kermadec Is., Raoul or Sunday I.: Denham B. flag staff ...... | 29 15 30 | 177 55 40 | 6 00 | 12 13 | 3.3 | 2.7 |
| | Macauley I.: Center..... | 30 15 00 | 178 31 45 | ........ | ........ | ...... | ...... |
| | Curtis I.: Center ........ | 30 35 00 | 178 37 00 | ........ | ........ | ...... | ...... |
| | | | Long. E. | | | | |
| | Conway Reef: Center................. | 21 44 45 | 174 37 45 | ........ | ........ | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

**ISLANDS OF THE PACIFIC—Continued.**

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | o ′ ″ | o ′ ″ | h. m. | h. m. | ft. | ft. |
| | Loyalty Is., Uvea or Halgan I.: Uvea Church | 20 27 06 | 166 35 25 | ......... | ......... | ...... | ...... |
| | Lifu I.: Wreck Bay, NW. shore | 20 46 00 | 167 02 30 | 6 30 | 0 18 | 4.2 | 2.5 |
| | Mare or Britannia I.: S. pt. | 21 42 00 | 168 00 00 | ......... | ......... | ...... | ...... |
| New Caledonia. | Port Kanala: Observatory | 21 29 12 | 165 58 50 | | | | |
| | Port St. Vincent: Marceau I. | 22 00 10 | 166 05 00 | 5 40 | 11 52 | 3.3 | 2.0 |
| | Noumea: Light-house | 22 16 22 | 166 25 52 | 8 25 | 2 13 | 3.1 | 1.9 |
| | Balari Pass: Amedée I. light | 22 28 44 | 166 28 51 | | | | |
| | Port Alcmene: Alcmene I. | 22 42 30 | 167 27 55 | 7 55 | 1 45 | 3.6 | 2.2 |
| | Norfolk Island: Inner end of jetty | 29 03 45 | 167 58 06 | 7 30 | 1 17 | 4.7 | 3.9 |
| | Elizabeth Reef: Center | 29 56 00 | 159 04 30 | ......... | ......... | ...... | ...... |
| | Lord Howe Island: S. end of middle beach | 31 31 38 | 159 05 58 | 8 20 | 2 08 | 5.4 | 3.3 |
| | Balls Pyramid: Summit, 1,816 ft. | 31 45 10 | 159 16 10 | ......... | ......... | ...... | ...... |
| | Macquarie Island: N. pt. | 54 19 00 | 158 56 00 | ......... | ......... | ...... | ...... |
| | Auckland Is.: Port Ross, Terror Cove. | 50 32 15 | 166 13 20 | 11 50 | 5 38 | 3.2 | 2.6 |
| | Campbell Island: S. harbor, Shoal Pt. | 52 33 26 | 169 08 41 | 11 45 | 5 33 | 3.5 | 2.9 |
| | Antipodes Island: Summit, 600 ft. | 49 42 00 | 178 43 05 | 3 20 | 9 30 | 5.3 | 4.3 |
| | Bounty Islands: Anchorage N. I., West Group | 47 43 00 | 179 00 27 | ......... | ......... | ...... | ...... |
| | Chatham Island, Whare-Kauri Island: Port Waitangi, Pt. Hanson | 43 57 24 | Long. W. 176 32 15 | ......... | ......... | ...... | ...... |
| | Chatham Island, Whare-Kauri Island: Port Hutt, Gordon Pt | 43 49 03 | 176 42 00 | 5 22 | 0 23 | 2.5 | 2.1 |

**AUSTRALIA.**

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. H. W. | Lun. Int. L. W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| North Australia. | Groate Eylandt: SE. pt | 14 16 00 | 136 58 00 | ......... | ......... | ...... | ...... |
| | Bickerton Island: Summit | 13 45 00 | 136 15 00 | ......... | ......... | ...... | ...... |
| | Cape Arnheim: Extreme | 12 14 00 | 137 00 00 | ......... | ......... | ...... | ...... |
| | Cape Wilberforce: E. extreme | 11 53 00 | 136 34 00 | 8 00 | 1 48 | 9.8 | 5.8 |
| | Cape Wessel: Extreme | 10 59 00 | 136 46 00 | | | | |
| | Dale Point: Extreme | 11 36 00 | 136 07 00 | | | | |
| | Cape Stewart: Extreme | 11 57 00 | 134 45 00 | ......... | ......... | ...... | ...... |
| | Liverpool River: W. pt. entrance | 11 54 00 | 134 12 00 | 6 17 | 0 05 | 12.0 | 7.1 |
| | Cape Croker: Extreme | 10 57 00 | 132 36 30 | | | | |
| | Port Essington: Government house | 11 22 02 | 132 09 18 | | | | |
| | Melville Island: Cape Van Diemen | 11 08 00 | 130 19 00 | | | | |
| | Bathurst Island: Cape Fourcróy | 11 51 00 | 129 58 00 | ......... | ......... | ...... | ...... |
| | Adelaide River: E. entrance pt | 12 13 20 | 131 16 30 | 5 15 | 11 27 | 16.8 | 9.9 |
| | Port Darwin: Charles Pt. light | 12 23 20 | 130 37 00 | 4 57 | 11 18 | 17.0 | 10.0 |
| | Port Patterson: Quail Islet | 12 30 58 | 130 27 00 | 3 50 | 10 00 | 16.7 | 9.9 |
| | Port Keats: Tree Pt. | 13 59 00 | 129 37 00 | 5 45 | 11 58 | 21.9 | 12.9 |
| | Pearce Point: Extreme | 14 25 50 | 129 20 42 | 6 45 | 0 27 | 23.0 | 13.6 |
| | Victoria River: Water Valley | 15 13 45 | 129 48 14 | ......... | ......... | ...... | ...... |
| Western Australia. | Cape Dussejour: Rock off cape | 14 42 00 | 128 10 00 | ......... | ......... | ...... | ...... |
| | Cape Londonderry: Extreme | 13 44 00 | 126 57 00 | ......... | ......... | ...... | ...... |
| | Cape Bougainville: Extreme | 13 52 00 | 126 12 00 | ......... | ......... | ...... | ...... |
| | Cassini Island: S. pt | 13 57 07 | 125 38 45 | ......... | ......... | ...... | ...... |
| | Cape Voltaire: Flat Hill | 14 15 00 | 125 39 00 | ......... | ......... | ...... | ...... |
| | Barker Islets: Center | 13 55 00 | 124 55 00 | ......... | ......... | ...... | ...... |
| | Montalivet Islands: W. islet | 14 14 00 | 125 12 00 | ......... | ......... | ...... | ...... |
| | Maret Islets: N. islet | 14 23 00 | 125 00 00 | ......... | ......... | ...... | ...... |
| | Colbert Islet: Center | 14 51 00 | 124 42 00 | ......... | ......... | ...... | ...... |
| | Prince Regent River: Mount Trafalgar | 15 16 36 | 125 07 00 | ......... | ......... | ...... | ...... |
| | Port Nelson: Careening beach | 15 06 00 | 125 01 00 | ......... | ......... | ...... | ...... |
| | De Freycinet Islets: Beacon on summit | 14 59 20 | 124 32 11 | ......... | ......... | ...... | ...... |
| | Red Islet: Center | 15 13 15 | 124 14 00 | ......... | ......... | ...... | ...... |
| | Cockell Islet: W. pt. | 15 46 00 | 124 04 00 | ......... | ......... | ...... | ...... |

MARITIME POSITIONS AND TIDAL DATA.

**AUSTRALIA—Continued.**

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Western Australia. | MacLeay Islets: Rock off N. end | 15 52 00 | 123 45 00 | | | | |
| | Port Usborne: S. pt | 15 39 25 | 123 36 27 | | | | |
| | Fitz Roy River: Escape Pt | 17 24 25 | 123 39 47 | | | | |
| | Cape L'Evèque: Extreme | 16 23 00 | 122 55 45 | | | | |
| | Lacepede Island: NW. islet | 16 50 00 | 122 05 30 | | | | |
| | Cape Baskerville: Extreme | 17 09 00 | 122 15 00 | | | | |
| | Cape Latouche Tréville: Extreme | 18 29 00 | 121 54 00 | | | | |
| | Turtle Isles: Center of N. isle | 19 54 00 | 118 48 00 | | | | |
| | Cape Lambert: Extreme | 20 36 00 | 117 11 00 | 11 30 | 5 10 | 17.6 | 10.4 |
| | Legendre Island: NW. extreme | 20 19 00 | 116 45 00 | | | | |
| | Rosemary Island: W. summit | 20 27 00 | 116 30 00 | | | | |
| | Enderby Island: Rocky Head | 20 35 00 | 116 23 00 | | | | |
| | Montebello Island: N. extreme of reef | 20 16 45 | 115 22 00 | | | | |
| | Barrow Island: N. pt | 20 40 40 | 115 27 45 | | | | |
| | Northwest Cape: Extreme | 21 46 41 | 114 10 08 | | | | |
| | Cape Cuvier: Extreme | 24 00 00 | 113 21 00 | | | | |
| | Cape Inscription: Extreme | 25 29 19 | 112 57 09 | | | | |
| | Houtman Rocks: N. islet | 28 18 05 | 113 35 33 | | | | |
| | Port Gregory | 28 12 00 | 114 14 30 | | | | |
| | Cape Leschenault: Extreme | 31 18 00 | 115 30 00 | | | | |
| | Rottnest Island: Light-house | 32 00 20 | 115 30 12 | | | | |
| | Perth (Fremantle): Arthur Head light | 32 03 12 | 115 44 23 | [10 16] | [3 43] | [2.1] | |
| | Peel: Robert Pt | 32 27 00 | 115 44 00 | | | | |
| | Cape Naturaliste: Extreme | 33 31 45 | 115 00 15 | | | | |
| | Cape Leeuwin: Light-house | 34 21 55 | 115 08 00 | | | | |
| | D'Entrecasteaux Point: Extreme | 34 52 00 | 116 01 00 | | | | |
| | Nuyts Point: Extreme | 35 05 00 | 116 38 00 | | | | |
| | West Cape Howe: Extreme | 35 09 00 | 117 40 00 | | | | |
| | Eclipse Islets: Summit of largest | 35 11 54 | 117 53 45 | | | | |
| | King George Sound: Commissariat house near Albany jetty | 35 02 20 | 117 54 04 | [10 53] | [4 40] | [2.6] | |
| | Bald Isle: Center | 34 55 00 | 118 27 00 | | | | |
| | Hood Point: Doubtful Isles | 34 24 00 | 119 34 00 | | | | |
| | Recherche Archipelago: Termination Isle | 34 30 00 | 121 58 00 | | | | |
| | Cuiver Point: Extreme | 32 57 00 | 124 39 00 | | | | |
| | Dover Point: Extreme | 32 34 00 | 125 30 00 | | | | |
| South Australia. | Fowler Point: Extreme | 32 01 30 | 132 33 00 | 11 50 | 9 35 | 5.1 | 0.3 |
| | Streaker Bay: Port Blanche | 32 48 00 | 134 13 40 | | | | |
| | Coffin Bay: Mount Dutton | 34 29 29 | 135 24 56 | 0 35 | 6 55 | 5.5 | 0.3 |
| | Cape Catastrophe: W. pt | 35 00 15 | 135 56 09 | | | | |
| | Neptune Isles: SE. islet | 35 20 15 | 136 06 24 | | | | |
| | Port Lincoln: English Church | 34 43 22 | 135 51 03 | | | | |
| | Franklin Harbor: Observation spot | 33 44 08 | 136 57 22 | | | | |
| | Port Augusta: Flagstaff | 32 29 42 | 137 45 24 | 8 20 | 2 15 | 11.4 | 0.7 |
| | Port Victoria: Wardang Island hut | 34 28 25 | 137 22 21 | | | | |
| | Cape Spencer: S. pt | 35 18 21 | 136 53 30 | | | | |
| | Investigator Strait: Troubridge light | 35 07 31 | 137 49 39 | | | | |
| | Port Wakefield: Light-house | 34 12 00 | 138 09 00 | 4 31 | 10 45 | 10.2 | 0.6 |
| | Port Adelaide: Wonga Shoal light | 34 50 25 | 138 26 58 | 4 04 | 10 22 | 6.3 | 0.9 |
| | Cape Jervis: Light-house | 35 36 45 | 138 05 29 | | | | |
| | Cape Borda: Light-house | 35 45 30 | 136 34 39 | | | | |
| | Cape Willoughby: Light-house | 35 51 00 | 138 07 45 | 4 00 | 10 15 | 5.8 | 0.3 |
| | Port Victor: Flagstaff | 35 34 06 | 138 37 09 | | | | |
| | Cape Jaffa: Margaret Brock light-house | 36 57 00 | 139 39 39 | | | | |
| | Cape Northumberland: Light-house | 38 04 18 | 140 39 40 | 11 52 | 5 40 | 4.2 | 0.2 |
| Victoria. | Cape Nelson: S. extreme | 38 26 00 | 141 32 39 | | | | |
| | Portland Bay: Lawrence Rock | 38 24 39 | 141 40 02 | 0 20 | 6 35 | 2.7 | 2.1 |
| | Port Fairy: Griffith Island summit | 38 23 47 | 142 14 37 | | | | |
| | Cape Otway: Light-house | 38 51 45 | 143 30 39 | | | | |
| | King Island: Cape Wickham light | 39 35 38 | 143 57 03 | | | | |
| | Port Phillip: Point Lonsdale light | 38 18 00 | 144 37 00 | 10 43 | 4 30 | 2.5 | 1.9 |
| | Geelong: Custom-house | 38 08 52 | 144 21 47 | 2 02 | 8 20 | 3.0 | 2.3 |
| | Melbourne: Observatory | 37 49 53 | 144 58 35 | 2 19 | 8 41 | 1.9 | 1.5 |

## MARITIME POSITIONS AND TIDAL DATA.

### AUSTRALIA—Continued.

| Coast | Place. | Lat. S. | Long. E. | Lun. Int. H.W. | Lun. Int. L.W. | Range. Spg. | Range. Neap. |
|---|---|---|---|---|---|---|---|
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Victoria. | Cape Schanck: Light-house | 38 29 42 | 144 52 51 | | | | |
| | Port Western: Extreme of W. head | 38 29 15 | 145 01 34 | | | | |
| | Wilson Promontory: Light, SE. pt | 39 08 00 | 146 25 16 | | | | |
| | Kent Island: Deal Island light | 39 29 45 | 147 18 39 | | | | |
| | Flinders Is.: Strzelecki Peaks, SE. peak | 40 11 45 | 148 04 00 | | | | |
| | Goose Island: Light on S. end | 40 18 40 | 147 47 39 | 10 38 | 4 25 | 8.1 | 6.2 |
| | Banks Strait: Swan Island light | 40 43 40 | 148 07 24 | | | | |
| | Port Albert: Light-house | 38 45 06 | 146 37 43 | | | | |
| | Gabo Island: Light-house | 37 34 15 | 149 55 10 | 8 40 | 2 27 | 4.5 | 3.4 |
| | Cape Howe (east): Extreme | 37 30 10 | 149 58 39 | | | | |
| New South Wales. | Cape Green: SE. pt | 37 15 40 | 150 03 04 | | | | |
| | Twofold Bay: Lookout Pt. light | 37 04 18 | 149 54 45 | 8 05 | 1 52 | 5.2 | 3.1 |
| | Dromedary Mountain: Summit | 36 18 30 | 150 01 34 | | | | |
| | Montagu Island: Light-house | 36 14 30 | 150 13 34 | 8 20 | 2 07 | 5.3 | 3.2 |
| | Bateman Bay: Observation head | 35 43 58 | 150 12 34 | | | | |
| | Ulladulla: Inner end of pier | 35 21 41 | 150 29 29 | 8 20 | 2 07 | 5.4 | 3.3 |
| | Jervis Bay: Light-house | 35 09 15 | 150 46 26 | | | | |
| | Kiama Harbor: Outer extreme of S. head | 34 40 25 | 150 52 19 | | | | |
| | Wollongong: Summit of head | 34 25 30 | 150 55 14 | | | | |
| | Sydney: Observatory | 33 51 41 | 151 12 23 | 8 40 | 2 27 | 4.2 | 2.5 |
| | Port Jackson: Outer S. head light | 33 51 30 | 151 18 15 | | | | |
| | Broken Bay: Baranjo Head light | 33 35 00 | 151 20 30 | | | | |
| | Newcastle: Nobby Head light | 32 55 15 | 151 48 19 | 8 35 | 2 23 | 4.7 | 2.8 |
| | Port Stephens: Light-house | 32 45 10 | 152 13 20 | 8 15 | 2 00 | 5.8 | 3.6 |
| | Sugar Loaf Point: Light-house | 32 26 20 | 152 33 40 | | | | |
| | Port Macquarie: Entrance | 31 25 30 | 152 55 19 | 9 00 | 2 46 | 4.1 | 2.4 |
| | Solitary Islands: S. Isle light | 30 12 00 | 153 17 00 | | | | |
| | Clarence River: S. Head light | 29 25 30 | 153 23 10 | 8 15 | 2 00 | 4.0 | 2.4 |
| Queensland. | Richmond River: N. Head light | 28 51 30 | 153 35 55 | | | | |
| | Brisbane: Signal station | 27 27 32 | 153 01 48 | 10 45 | 4 30 | 6.4 | 3.9 |
| | Lookout Point: Extreme | 27 26 20 | 153 33 50 | | | | |
| | Cape Moreton: Light-house | 27 02 10 | 153 28 04 | | | | |
| | Double Island Point: Light-house | 25 56 00 | 153 13 00 | | | | |
| | Indian Head: Extreme | 25 00 15 | 153 23 00 | | | | |
| | Sandy Cape: Light-house | 24 43 20 | 153 13 40 | | | | |
| | Burnett River: S. Head light | 24 45 00 | 152 25 00 | | | | |
| | Lady Elliot Islet: Light-house | 24 07 00 | 152 45 15 | | | | |
| | Bustard Head: Light-house | 24 01 20 | 151 41 04 | | | | |
| | Rodd Bay: Spit end | 24 01 20 | 151 37 15 | | | | |
| | Port Curtis: Gatcombe Head light | 23 53 00 | 151 23 50 | | | | |
| | Cape Capricorn: Light-house | 23 29 30 | 151 14 04 | | | | |
| | Port Bowen: Observation rock | 22 31 40 | 150 45 44 | | | | |
| | Percy Isles: Pine I. light | 21 39 00 | 150 14 00 | | | | |
| | Northumberland Isles: Summit of Prud-hoe I | 21 19 15 | 149 43 30 | | | | |
| | Cape Palmerston: N. extreme | 21 32 00 | 149 31 04 | | | | |
| | Cape Conway: SE. pt | 20 32 20 | 148 58 00 | | | | |
| | Port Molle: S. side of entrance | 20 18 50 | 148 53 15 | | | | |
| | Cumberland Island: Whitsunday I., summit on W. side | 20 15 30 | 149 00 00 | | | | |
| | Port Denison: Obs. pt., W. side of Stone Isle | 20 00 50 | 148 16 54 | 10 05 | 3 53 | 9.0 | 5.4 |
| | Gloucester Island: Summit near N. end. | 19 57 30 | 148 27 34 | | | | |
| | Holborne Islet: Center | 19 41 50 | 148 23 00 | | | | |
| | Cape Bowling Green: Light-house | 19 19 20 | 147 27 40 | | | | |
| | Cape Cleveland: Light-house | 19 11 25 | 147 01 10 | | | | |
| | Palm Islands: SE. point of SE. island | 18 45 30 | 146 42 50 | | | | |
| | Rockingham Bay: Peak of Goold Isle | 18 09 30 | 146 11 04 | | | | |
| | Barnard Island: Light-house | 17 40 40 | 146 11 00 | | | | |
| | Frankland Island: High islet | 17 09 45 | 146 02 30 | | | | |
| | Cape Tribulation: Extreme | 16 04 20 | 145 29 34 | | | | |
| | Hope Island: S. islet | 15 45 00 | 145 28 30 | | | | |
| | Cook Mountain: Summit | 15 29 45 | 145 17 30 | 8 55 | 2 43 | 7.5 | 4.5 |
| | Cape Bedford: SE. extreme | 15 16 30 | 145 23 15 | | | | |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### AUSTRALIA—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Queensland. | Murdock Point: Extreme | 14 37 15 | 144 57 30 | | | | |
| | Cape Melville: NE. extreme | 14 10 00 | 144 32 34 | | | | |
| | Flinders Island: N. extreme of N. island. | 14 07 45 | 144 15 19 | | | | |
| | Claremont Point: Extreme | 14 00 30 | 143 42 15 | | | | |
| | Cape Sidmouth: Extreme | 13 24 45 | 143 36 19 | 9 00 | 2 47 | 9.6 | 5.8 |
| | Cape Direction: NE. extreme | 12 51 00 | 143 34 00 | | | | |
| | Cape Grenville: Extreme | 11 58 15 | 143 15 15 | | | | |
| | Sir Charles Hardy Island: N. extreme of SE. isle | 11 55 00 | 143 29 00 | | | | |
| | Bird Island: NW. isle | 11 46 30 | 143 06 00 | | | | |
| | Hannibal Isles: E. isle | 11 36 30 | 142 56 19 | | | | |
| | Cape York: Sextant Rock | 10 41 30 | 142 32 24 | 1 00 | 7 10 | 8.0 | 4.7 |
| | Mount Adolphus: Summit | 10 37 45 | 142 39 20 | | | | |
| | Travers Isles: Center | 10 22 00 | 142 21 19 | | | | |
| | Prince of Wales Island: Cape Cornwall, extreme | 10 46 00 | 142 10 50 | | | | |
| | Booby Island: Center | 10 36 05 | 141 53 49 | 4 20 | 10 30 | 7.8 | 4.7 |
| | Flinders River: Entrance | 17 36 40 | 140 37 06 | | | | |
| | Albert River: Kangaroo Pt | 17 35 10 | 139 45 56 | | | | |
| | Sweers Island: Inscription Pt | 17 06 50 | 139 38 36 | | | | |

### TASMANIA.

| | Place. | Lat. S. | Long. E. | H. W. | L. W. | Spg. | Neap. |
|---|---|---|---|---|---|---|---|
| | Cape Portland: NW. pt | 40 44 15 | 147 56 09 | | | | |
| | Port Dalrymple: Low Head light | 41 03 25 | 146 47 54 | 11 10 | 5 00 | 9.0 | 6.9 |
| | Port Sorrell: NW. entrance head | 41 07 05 | 146 33 30 | | | | |
| | Port Frederick: Entrance | 41 10 00 | 146 24 30 | | | | |
| | Leven River: W. entrance head | 41 08 30 | 146 12 00 | | | | |
| | Emu Bay: Blackman Pt | 41 02 50 | 145 56 39 | | | | |
| | Hunter Island: N. pt | 40 23 40 | 144 47 45 | | | | |
| | Cape Grim: Outer Doughboy Islet | 40 40 10 | 144 39 44 | | | | |
| | Albatross Islet: N. pt | 40 22 00 | 144 39 19 | | | | |
| | Arthur River: Entrance | 41 04 00 | 144 44 00 | | | | |
| | Pieman River: Rocks close to entrance. | 41 41 00 | 144 57 00 | | | | |
| | Macquarie Harbor: Entrance Islet | 42 11 37 | 145 12 34 | 7 20 | 1 07 | 2.7 | 2.1 |
| | Cape Sorrell: Light-house | 42 11 00 | 145 10 30 | | | | |
| | Port Davey: Pollard Head | 43 19 00 | 145 53 00 | | | | |
| | Southwest Cape: Extreme pt | 43 33 30 | 146 01 04 | | | | |
| | Mewstone Rock: Center | 43 44 30 | 146 22 04 | | | | |
| | Cape Bruny: Light-house | 43 29 40 | 147 08 49 | | | | |
| | Bruny Island: Penguin Islet | 43 21 00 | 147 23 40 | | | | |
| | Hobart Town: Transit of Venus station. | 42 53 25 | 147 20 07 | 8 05 | 1 52 | 4.2 | 3.2 |
| | Cape Pillar: Tasman Islet | 43 14 00 | 148 02 00 | | | | |
| | Cape Frederik Hendrik: Extreme | 42 52 00 | 148 00 00 | | | | |
| | Freycinet Peninsula: Summit | 42 13 00 | 148 18 04 | | | | |
| | St. Patrick Head: N. pt | 41 34 00 | 148 19 30 | | | | |
| | Eddystone Point: Extreme | 40 59 40 | 148 20 50 | | | | |

### NEW ZEALAND.

| Coast. | Place. | Lat. S. | Long. E. | H. W. | L. W. | Spg. | Neap. |
|---|---|---|---|---|---|---|---|
| North I. | Three Kings Islands: NE. extreme of NE. island | 34 06 20 | 172 08 49 | | | | |
| | North Cape: Cape Islet | 34 25 07 | 173 03 34 | | | | |
| | Parenga-renga Harbor: Kohan Pt | 34 31 00 | 173 00 54 | | | | |
| | Maunganui Harbor: White Pt | 35 00 20 | 173 32 39 | | | | |
| | Wangaroa Harbor: Peach Islet | 35 01 44 | 173 45 48 | 7 40 | 1 30 | 6.4 | 4.5 |
| | Bay of Islands: Motu Mea Islet | 35 17 00 | 174 06 06 | 7 26 | 1 55 | 5.9 | 4.2 |

MARITIME POSITIONS AND TIDAL DATA.

**NEW ZEALAND**—Continued.

| Coast. | Place. | Lat. S. | Long. E. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| North Island. | Wangaruru Harbor: Grove Pt.......... | 35 23 48 | 174 21 24 | 7 15 | 1 05 | 6.5 | 4.6 |
| | Wangari Harbor: Loot Pt.............. | 35 51 09 | 174 31 14 | 7 05 | 0 55 | 6.7 | 4.8 |
| | Great Barrier Island: Needles Pt....... | 36 01 15 | 175 25 34 | ....... | ....... | ....... | ....... |
| | Auckland Harbor: Light-house......... | 36 50 06 | 174 51 00 | 7 20 | 1 10 | 10.8 | 7.7 |
| | Coromandel Harbor: Tuhnia I ......... | 36 48 35 | 175 24 34 | 7 05 | 0 55 | 10.7 | 7.6 |
| | Cape Colville: N. pt ................... | 36 28 20 | 175 21 04 | ....... | ....... | ....... | ....... |
| | Cuvier Island: Light-house............. | 36 26 20 | 175 49 00 | ....... | ....... | ....... | ....... |
| | Tauranga Harbor: Mount Maunganui, 860 ft ............................... | 37 36 25 | 176 10 14 | 7 05 | 0 55 | 6.1 | 4.4 |
| | White Island: Summit, 863 ft ......... | 37 30 00 | 177 10 49 | ....... | ....... | ....... | ....... |
| | Cape Runaway: Extreme .............. | 37 30 45 | 177 59 34 | 8 10 | 2 00 | 6.6 | 4.7 |
| | East Cape: Islet, 420 ft .............. | 37 40 00 | 178 35 09 | 8 00 | 1 50 | 6.8 | 5.8 |
| | Tolaga Bay: Matu-heka Islet........... | 38 20 50 | 178 20 14 | ....... | ....... | ....... | ....... |
| | Mahia Peninsula: S. extreme of Portland I ...... | 39 18 00 | 177 53 15 | ....... | ....... | ....... | ....... |
| | Ahuriri Harbor: Light-house.......... | 39 28 30 | 176 54 14 | 6 05 | 12 15 | 3.5 | 3.0 |
| | Kidnappers Cape: Extreme ............ | 39 38 00 | 177 06 44 | ....... | ....... | ....... | ....... |
| | Cape Palliser: Light-house ........... | 41 36 45 | 175 18 45 | 4 40 | 10 50 | 5.7 | 4.9 |
| | Port Nicholson: Pencarrow light....... | 41 21 40 | 174 51 04 | ....... | ....... | ....... | ....... |
| | Wellington: Queen's Wharf light ...... | 41 17 17 | 174 47 25 | 4 52 | 10 54 | 3.6 | 3.1 |
| | Mana-watu River: Light-house ........ | 40 27 10 | 175 14 40 | 9 40 | 3 30 | 6.3 | 5.4 |
| | Wanganui River: N. head.............. | 39 57 00 | 174 59 44 | ....... | ....... | ....... | ....... |
| | Egmont Mountain: Summit, 8,270 ft... | 39 18 00 | 174 03 59 | ....... | ....... | ....... | ....... |
| | New Plymouth: Flag-staff............. | 39 03 35 | 174 04 35 | 9 15 | 3 05 | 11.6 | 8.2 |
| | Kawhia Harbor: S. head.............. | 38 04 50 | 174 48 04 | 9 10 | 3 00 | 11.9 | 8.5 |
| | Aotea Harbor: S. head............... | 37 59 35 | 174 50 04 | ....... | ....... | ....... | ....... |
| | Whaingaroa Harbor: S. entrance pt.... | 37 46 22 | 174 52 19 | 9 08 | 2 55 | 12.3 | 8.7 |
| | Manukau Harbor: Paratutai flag-staff.. | 37 03 00 | 174 31 14 | 9 05 | 2 50 | 12.6 | 9.0 |
| | Kaipara Harbor: Light-house......... | 36 23 00 | 174 08 00 | 9 00 | 2 50 | 10.0 | 7.1 |
| | Hokianga River: Flag-staff at entrance. | 35 32 05 | 173 21 59 | 8 40 | 2 30 | 9.2 | 6.5 |
| South Island. | Cape Campbell: Light-house ........... | 41 44 00 | 174 17 14 | 4 45 | 11 00 | 7.5 | 6.5 |
| | Port Cooper: Lyttleton custom-house .. | 43 46 40 | 172 44 17 | 3 45 | 10 00 | 7.4 | 5.8 |
| | Akaroa Island: Light-house........... | 43 54 00 | 173 00 20 | ....... | ....... | ....... | ....... |
| | Ashburton River: N. entrance pt ...... | 44 04 50 | 171 48 34 | ....... | ....... | ....... | ....... |
| | Waitangi River: N. entrance head..... | 44 54 50 | 171 11 14 | ....... | ....... | ....... | ....... |
| | Otago Harbor: Taivoa Head light...... | 45 46 55 | 170 44 02 | 3 31 | 9 39 | 5.6 | 4.4 |
| | Molyneux Bay: Landing place......... | 46 24 05 | 169 47 53 | ....... | ....... | ....... | ....... |
| | Nugget Point: Light-house ............ | 46 27 10 | 169 50 04 | ....... | ....... | ....... | ....... |
| | Bluff Harbor: Light-house ............ | 46 37 00 | 168 23 00 | 1 05 | 7 15 | 7.8 | 6.2 |
| | Tewaewae Bay: Pahia Pt............. | 46 20 40 | 167 42 19 | ....... | ....... | ....... | ....... |
| | Solander Islands: Summit, 1,100 ft..... | 46 36 00 | 166 54 04 | ....... | ....... | ....... | ....... |
| | Preservation Inlet: Light-house........ | 46 10 00 | 166 38 15 | 11 10 | 5 00 | 7.5 | 5.9 |
| | West Cape: Extreme................... | 45 54 50 | 166 25 49 | ....... | ....... | ....... | ....... |
| | Queenstown: U. S. Tr. of Venus station. | 45 02 07 | 168 40 06 | ....... | ....... | ....... | ....... |
| | Milford Sound: Freshwater Basin ..... | 44 40 20 | 167 54 45 | ....... | ....... | ....... | ....... |
| | Cascade Point: N. extreme............ | 44 00 30 | 168 21 34 | ....... | ....... | ....... | ....... |
| | Grey River: Entrance................. | 42 26 20 | 171 11 54 | 10 10 | 4 00 | 9.8 | 7.7 |
| | Hokitika: Entrance light.............. | 42 42 20 | 170 59 30 | 10 20 | 4 10 | 9.5 | 7.5 |
| | Cape Foulwind: Light-house .......... | 41 45 40 | 171 27 44 | ....... | ....... | ....... | ....... |
| | Cape Farewell: Extreme .............. | 40 29 50 | 172 41 04 | ....... | ....... | ....... | ....... |
| | Nelson: Bowlder Bank light........... | 41 16 05 | 173 17 30 | 9 55 | 3 45 | 12.0 | 9.4 |
| | D'Urville Island: Port Hardy.......... | 40 46 35 | 173 54 04 | 9 45 | 3 35 | 11.6 | 9.2 |
| | Port Gore: Head of Melville Cove..... | 41 01 55 | 174 11 22 | ....... | ....... | ....... | ....... |
| | Port Underwood: Flag Pt............. | 41 20 28 | 174 08 24 | 6 00 | 12 15 | 7.6 | 6.6 |
| Stewart I. | Port William: Howell's House......... | 46 50 30 | 168 05 34 | ....... | ....... | ....... | ....... |
| | Paterson Inlet: Glory Cove........... | 46 58 30 | 168 09 54 | 1 00 | 9 15 | 7.8 | 6.2 |
| | Port Adventure: White Beach, S. end.. | 47 03 52 | 168 10 57 | ....... | ....... | ....... | ....... |
| | Port Pegasus: Cove abreast Anchorage I........ | 47 11 40 | 167 40 51 | 11 45 | 5 40 | 7.9 | 6.2 |
| | Codfish Island: NW. extreme ......... | 46 45 45 | 167 36 49 | ....... | ....... | ....... | ....... |
| | Snares Islands: SW. islet.............. | 48 06 43 | 166 27 44 | ....... | ....... | ....... | ....... |

# APPENDIX IV.

## MARITIME POSITIONS AND TIDAL DATA.

### THE ARCTIC REGIONS.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| | Cape Walsingham: Extreme | 66 00 00 | 69 28 00 | | | | |
| | Mile Island: N. pt | 64 04 00 | 77 50 00 | | | | |
| | Marble Island: E. end | 62 33 00 | 91 06 00 | 4 00 | 10 15 | 12.0 | 5.1 |
| | Cape Kendall: Extreme. | 63 42 00 | 87 15 00 | | | | |
| | Iglooik Island: E. pt | 69 21 00 | 81 31 00 | 6 50 | 0 40 | 8.0 | 4.2 |
| | Victoria Harbor: N. shore | 70 09 17 | 91 30 33 | | | | |
| | Elizabeth Harbor: Entrance | 70 38 14 | 92 10 56 | | | | |
| | Magnetic Pole, 1831 | 70 05 00 | 96 47 00 | | | | |
| | Port Neill: N. pt. of entrance | 73 09 13 | 89 00 54 | | | | |
| | Port Bowen: N. cove | 73 13 39 | 88 54 48 | | | | |
| | Batty Bay: S. pt. of entrance | 73 13 00 | 91 08 00 | | | | |
| | Port Leopold: Whaler Pt | 73 50 05 | 90 12 00 | 11 38 | 5 29 | 5.5 | 2.9 |
| | Careys Islands | 76 49 00 | 73 10 00 | | | | |
| | Discovery Harbor | 81 04 40 | 64 45 00 | | | | |
| | Alert's Winter Quarters | 82 27 00 | 61 18 00 | 10 35 | 4 20 | 2.6 | 1.0 |
| | Cape Joseph Henry: N. extreme | 82 40 00 | 63 38 00 | | | | |
| | Cape Hecla: N. extreme | 82 54 00 | 64 45 00 | | | | |
| | Cape Columbia: Extreme | 83 07 00 | 70 20 00 | | | | |
| | Melville Island: Winter Harbor | 74 47 10 | 110 48 15 | 1 20 | 7 40 | 3.8 | 1.9 |
| | North Cape | 68 55 00 | 179 57 00 | | | | |
| | | | Long. E. | | | | |
| | Liakhov Islands: E. pt. of New Siberia | 75 10 00 | 150 30 00 | | | | |
| | Cape Tscheljuskin: E. pt | 77 41 00 | 104 01 00 | | | | |
| | Nova Zembla: Vaigats I., N. pt | 70 25 00 | 59 10 00 | | | | |
| | Cape Costin (Kostina) | 70 55 00 | 53 01 50 | 10 00 | 3 50 | 7.0 | 4.0 |
| | NE. pt., Cape Desire | 76 58 00 | 65 40 00 | | | | |
| | Franz Josef Land: Wilczek I | 79 55 00 | 58 45 00 | | | | |
| | Mezen: Epiphany Church | 65 50 18 | 44 17 00 | | | | |
| | Morjovetz Island: Light-house | 66 45 50 | 42 30 00 | | | | |
| | Archangel: Trinity Church | 64 32 06 | 40 33 30 | 7 18 | 2 00 | 2.2 | 1.3 |
| | Jighinsk Island: Light-house | 65 12 17 | 36 51 30 | 5 05 | 11 30 | 3.8 | 2.1 |
| | Onega: St. Michael's Church | 63 53 36 | 38 08 30 | 9 02 | 3 10 | 9.1 | 5.2 |
| | Salovetski: Light-house | 65 07 00 | 35 37 00 | | | | |
| | Cape Sviatoi Nos: Light-house | 68 08 51 | 39 48 54 | 9 05 | 2 55 | 13.9 | 7.8 |
| | Bear Island | 74 30 00 | 20 00 00 | | | | |
| | Spitzbergen Island: S. cape | 76 35 00 | 17 23 00 | | | | |
| | Cloven Cliff | 79 50 00 | 11 40 30 | | | | |
| | Danes I., Robbe Bay | 79 42 00 | 11 07 00 | 0 14 | 6 25 | 5.3 | 3.0 |
| | (a) | | Long. W. | | | | |
| | Thank God Harbor | 81 38 00 | 61 44 00 | 12 14 | 5 58 | 5.4 | 2.0 |
| | Cape York: Extreme | 75 55 00 | 65 30 00 | | | | |
| | Upernivik: Flagstaff | 72 47 48 | 55 53 42 | 10 50 | 4 38 | 8.0 | 3.0 |
| | Proven: Village | 72 20 42 | 55 20 00 | | | | |
| | Omenak Island: Village | 70 40 00 | 51 59 00 | | | | |
| | Godhavn: Village | 69 14 04 | 53 24 07 | | | | |
| | Jacobshavn: Village | 69 13 12 | 50 56 30 | | | | |
| | Claushavn: Village | 69 07 30 | 50 55 30 | | | | |
| | Christianshaab: Village | 68 49 06 | 51 00 00 | | | | |
| | Egedesmunde: Village | 68 42 30 | 52 46 00 | | | | |
| Greenland. | Whalefish Island: Boat Inlet | 68 58 30 | 53 27 00 | 8 05 | 1 52 | 7.5 | 3.6 |
| | Holsteinberg: Village | 66 55 54 | 53 40 18 | 6 20 | 0 07 | 10.0 | 4.8 |
| | Kangamint | 65 48 42 | 53 23 00 | | | | |
| | Ny Sukkertop: Village | 65 24 30 | 52 54 00 | | | | |
| | Godthaab: Flagstaff | 64 10 36 | 51 45 48 | 6 40 | 0 27 | 12.5 | 6.0 |
| | Sermelik Fjord: Kasuk Peak | 63 29 12 | 51 10 48 | | | | |
| | Fiskernaes: Village | 63 05 12 | 50 43 36 | | | | |
| | Jensen Nunatak: Peak | 62 50 00 | 48 57 00 | | | | |
| | Ravn Storo: Peak | 62 42 36 | 50 20 48 | | | | |
| | Frederikshaab: Church | 61 59 36 | 49 44 00 | 6 12 | 0 00 | 9.0 | 3.6 |
| | Kangarssuk Havn: Village | 61 28 20 | 48 51 00 | | | | |
| | Arsuk: Pingo Beacon | 61 10 24 | 48 26 00 | 6 15 | 0 03 | 12.0 | 4.8 |
| | Kajartalik Island: Summit | 61 09 42 | 48 30 42 | | | | |
| | Ivigtuk: House | 61 12 12 | 48 10 30 | | | | |
| | Bangs Havn: Anchorage | 60 47 30 | 47 52 00 | | | | |
| | Aurora Harbor | 60 48 36 | 47 46 48 | | | | |

a Cape Morris Jesup (the most northern known land), 83° 39′ N., 30° 40′ W. (approx.).

## MARITIME POSITIONS AND TIDAL DATA.

### THE ARCTIC REGIONS—Continued.

| Coast. | Place. | Lat. N. | Long. W. | Lun. Int. | | Range. | |
|---|---|---|---|---|---|---|---|
| | | | | H. W. | L. W. | Spg. | Neap. |
| | | ° ′ ″ | ° ′ ″ | h. m. | h. m. | ft. | ft. |
| Greenland. | Julianshaab: Village................... | 60 43 07 | 46 01 00 | 4 56 | 11 09 | 7.0 | 2.8 |
| | Neunortalik: Village ................... | 60 08 12 | 45 16 00 | 5 33 | 11 46 | 8.6 | 3.4 |
| | Frederiksthal: Village ................. | 60 00 00 | 44 40 00 | 2 55 | 9 10 | 9.4 | 3.8 |
| | Cape Farewell: Staten Huk ............ | 59 49 00 | 44 01 42 | 4 00 | 10 13 | 7.5 | 3.0 |
| | Aleuk Islands: Center................. | 60 09 00 | 42 55 00 | ......... | ......... | ...... | ...... |
| | Cape Tordenskjold: Extreme.......... | 61 25 00 | 42 15 00 | ......... | ......... | ...... | ...... |
| | Cape Bille: Extreme.................. | 62 01 00 | 42 00 00 | ......... | ......... | ...... | ...... |
| | Cape Juul: Extreme.................. | 63 14 00 | 40 50 00 | ......... | ......... | ...... | ...... |
| | Cape Lowenorn: Extreme..:......... | 64 30 00 | 39 30 00 | ......... | ......... | ...... | ...... |
| | Dannesbrog Island: Beacon ........... | 65 18 00 | 38 30 00 | ......... | ......... | ...... | ...... |
| | Ingolsfjeld ........................... | 66 19 02 | 35 11 00 | ......... | ......... | ...... | ...... |
| | Rigny Mount: Summit................. | 69 00 12 | 26 10 24 | ......... | ......... | ...... | ...... |
| | Pendulum Islands ..................... | 74 40 00 | 18 17 00 | 11 05 | 4 53 | 6.7 | 3.9 |
| | Cape Philipp Broke................... | 74 55 00 | 17 33 00 | 11 10 | 4 58 | 3.7 | 2.1 |
| | Cape Bismark: Extreme .............. | 76 47 00 | 18 40 00 | ......... | ......... | ...... | ...... |
| | Jan Mayen Island: Mt. Beerenberg, 6,870 ft........ | 71 04 00 | 7 36 00 | ......... | ......... | ...... | ...... |
| | Youngs Foreland, or Cape Northeast ..... | 71 08 00 | 7 26 00 | ......... | ......... | ...... | ...... |
| | Mary Muss Bay.. | 71 00 00 | 8 28 00 | 11 21 | 5 06 | 3.8 | 2.2 |
| Iceland. | Langanaes Point....................... | 66 22 45 | 14 30 46 | ......... | ......... | ...... | ...... |
| | Rissnaes Point....................... | 66 32 40 | 16 10 24 | ......... | ......... | ...... | ...... |
| | Grimsey Norddranger: Tr. Station..... | 66 33 42 | 17 57 36 | ......... | ......... | ...... | ...... |
| | Skagataas Point ...................... | 66 07 30 | 20 05 26 | ......... | ......... | ...... | ...... |
| | North Cape: Kalfatindr............... | 66 27 29 | 22 23 04 | ......... | ......... | ...... | ...... |
| | Straumness Point..................... | 66 26 30 | 23 08 00 | ......... | ......... | ...... | ...... |
| | Fugle or Staabierg Huk: Point ........ | 65 30 15 | 24 31 26 | ......... | ......... | ...... | ...... |
| | Snaefells Yokul: Tr. Station........... | 64 48 04 | 23 45 08 | ......... | ......... | ...... | ...... |
| | Reykiavik: Observatory ............... | 64 08 40 | 21 55 00 | 5 10 | 11 25 | 14.5 | 8.4 |
| | Cape Skagi: Light-house.............. | 64 04 09 | 22 39 04 | ......... | ......... | ...... | ...... |
| | Reykianaes: Light-house.............. | 63 48 06 | 22 39 00 | ......... | ......... | ...... | ...... |
| | Ingolfshofde: Tr. Station............. | 63 48 19 | 16 36 13 | ......... | ......... | ...... | ...... |
| | Papey Island: Tr. Station............. | 64 35 42 | 14 08 31 | ......... | ......... | ...... | ...... |
| | Reythur Fjeld: Tr. Station............. | 64 55 27 | 13 41 10 | ......... | ......... | ...... | ...... |
| | Balatangi: Light-house ................ | 65 16 14 | 13 32 22 | ......... | ......... | ...... | ...... |
| | Dia Fjeld: Tr. Station ................ | 65 45 00 | 14 23 35 | ......... | ......... | ...... | ...... |

# INDEX TO APPENDIX IV.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES—continued.

PLACES —continued.

# APPENDIX V.

## LUNAR DISTANCES.

By reason of the comparative rapidity of motion of the moon relatively to the earth, it occurs that the angular distance, measured from the earth, between the moon and a body that occupies a fixed, or nearly fixed, position in the celestial sphere, is constantly changing. If, therefore, an observer accurately measures with a sextant the angle between the moon and one of the various celestial bodies for which the lunar distance is tabulated in the Nautical Almanac, this observed distance, reduced to true distance, affords a means for determining the absolute instant of time at which the observation was taken; and from this may be deduced the longitude and the chronometer error.

If it were practicable to obtain results with a close degree of accuracy by this method, it would be an invaluable aid to the navigator, eliminating all anxiety as to change of rate of the chronometer, and even rendering it possible to navigate a vessel without such an instrument. It is unfortunately the case, however, that the method does not afford results that may be regarded as reliable within small limits, since a very small error in the observed angle, which it may not be possible to avoid even though every care be taken, causes a large error in the deduced time. Navigators of the present day do not, therefore, employ the method of lunar distances except under extraordinary circumstances, such as when an accident to the chronometer occurs, or, on a very long voyage, when there is reason to suspect the correctness of the chronometer error as brought forward by the rate.

In order to facilitate the method of determining the longitude from lunar distances, there is published in the Nautical Almanac, for every third hour of Greenwich mean time, the angular distances of the center of the moon from the center of the sun, from the brightest planets and from certain bright fixed stars selected in the path of the moon. All the distances that can be observed on the same day are grouped together under that date, and the columns are read from left to right across both pages of the same opening. The letter W. or E. is affixed to the name of the sun, planet, or star to indicate that it is on the west or east side of the moon. An observer on the surface of the earth having measured a lunar distance, corrected it for instrumental errors and for the semidiameters of the objects, and cleared it from the effects of refraction and parallax, finds the *true* or *geocentric* distance. With this distance and the distances in the Nautical Almanac of the same bodies on the same day, the Greenwich mean time of the observation can be found, as will hereafter be described.

The unavoidable errors to which the observation of lunar distance is subject are diminished by making a number of measurements. Errors of the instrument may be diminished by measuring distances on opposite sides of the moon, when possible, and combining the results.

Before taking the observation, the Nautical Almanac must be examined to see from what objects the distances are computed. If the star or planet selected for observation is not recognized from its position relatively to other bodies in the heavens, it can easily be identified from the distance given in the Almanac; for the observer may set the sextant to the distance computed roughly for the estimated time at the meridian of Greenwich, and direct his sight to the east or west of the moon, according as the object is marked E. or W. in the Nautical Almanac, and, having found the reflected image of the moon upon the horizon glass, sweep the instrument to the right or left, and the image will pass over the star or planet sought, if above the horizon and the weather clear; the star or planet is always one of the brightest, and is situated nearly in the arc passing through the moon's center, perpendicular to the line connecting the two horns.

Although all the instruments used in these observations ought to be well adjusted, yet particular care should be taken of the sextant used in measuring the angular distance of the moon from the sun or star, since an error of 1′ in this distance will cause an error of nearly 30′ in the longitude deduced therefrom. When a great angular distance is to be measured it is absolutely necessary to use a telescope, and its parallelism with respect to the plane of the instrument must be carefully examined; but in measuring small distances the use of the telescope is not of such great importance, and a sight tube may then be used, taking care, however, that the eye and point of contact of the objects on the horizon glass be equally distant from the plane of the instrument. It is always conducive to accuracy to use a telescope, and, after a little practice, this is easily done.

While one person is observing the distance of the objects, two others should observe the altitudes. The chronometer should be under the eye of a fourth person appointed to note the time; the observer who takes the angular distance gives previous notice to the others to be ready with their altitudes by the time he has finished his observation, which, being done, the time, altitudes, and distance should be carefully noted; if other sets of observations are taken it must be done within the space of fifteen minutes, and the mean of all the observations should be worked as a single one.

When a ship is rolling considerably it is difficult to measure the distance of the objects, but when steady there is much less difficulty, especially in small distances, which are much more easily measured than large ones, and are not so liable to error from an ill adjustment of the telescope; an observer would therefore do well to choose those times for observation when the distance of the objects is less than 70° or 80°. But it must be observed that neither of the objects, if possible, ought to be at a less altitude than 10°, on account of the uncertainty of the refraction near the horizon, for the horizontal refraction varies from 33′ to 36′ 40″ by an alteration of 40° in the thermometer; this alteration might cause an error of 2° in the longitude with an observer who uses the mean refraction.

In measuring the distance of the moon from the sun we must bring the moon's round limb in contact with the nearer limb of the sun. In measuring the distance of the moon from a planet or fixed star the round limb must be brought in contact with the center of the star or planet, observing that, the semidiameter of the planet being only a few seconds, the center of it can be estimated sufficiently near for all the purposes of this observation.

In taking the altitude of the moon, the round limb, whether it be the upper or lower, must be brought to the horizon. In misty weather it is rather difficult to observe the altitude of the stars on account of their dimness. Sometimes they are so dim that they can not be seen through the telescope of a sextant, particularly if the mirrors are not well silvered. In this case the telescope must be laid aside and the altitude taken with a sight tube.

It has been assumed that there were observers enough to measure the altitudes when the distance was observed, but if that is not the case the altitudes may be estimated in a manner to be explained hereafter.

The method here given is that of Professor Chauvenet, and involves the use of the tables in this Appendix. The object of these tables is to give the true correction of a lunar distance in all cases when, with the apparent distance of the moon from the sun, a planet, or star, the apparent altitudes of the two objects have also been obtained by observation. They enable us readily to take into account: First, the parallax of the moon in the latitude of the observer, allowing for the spheroidal figure of the earth; second, the parallax of the sun or a planet; third, the true atmospheric refraction, allowing for the actual state of the air as shown by the barometer and thermometer; and, fourth, that effect of refraction which gives the apparent disks of the moon and sun an oval or elliptical figure.

The longitude deduced from a lunar observation, when no attention is paid to the spheroidal figure of the earth, to the barometer and thermometer, or to the elliptical figure of the disks, may in certain cases be in error a whole degree. It is true these extreme cases are rare in practice, but cases are common in which from such neglect the error in the longitude is 10′, 15′, or 20′, and it is absolutely necessary to get rid of such errors and to leave no other inaccuracy in the result than that which unavoidably follows from the observations.

THE OBSERVATION.—The record of a complete observation embraces:

1. The latitude and approximate longitude of the place of observation.
2. The approximate local time.
3. The time of observation as shown by a chronometer, and the error of the chronometer, or its difference from mean Greenwich time.
4. The apparent distance of the moon's bright limb from a star or planet, or from the nearer limb of the sun.
5. The apparent altitude of the moon's upper or lower limb above the sea horizon.
6. The apparent altitude of the star, planet, or lower limb of the sun above the sea horizon.
7. The height of the barometer and thermometer.
8. The height of the eye above the level of the sea.
9. The index correction of the sextant.

The index correction of the sextant may be supposed to be previously determined; but, since even in the best instruments it is not constant, its determination should be considered a necessary part of the observation.

The error of the chronometer alluded to is that which is obtained by applying the daily rate (multiplied by the proper number of days) to the error found before leaving port. The agreement or disagreement of the error thus found with that found by the lunar observation will be the test of the accuracy of the chronometer, subject, of course, to the accepted limits of accuracy of the observation itself.

PREPARATION OF THE DATA.—*Greenwich Date.*—Correct the chronometer time for its error from Greenwich time and deduce the Greenwich date, i. e., the Greenwich day and hour (mean time), reckoning the hours in succession from 0 to 24, beginning at noon.

*Nautical Almanac.*—With the Greenwich date enter the Almanac and take out the moon's semidiameter and horizontal parallax; if the sun is observed, take its semidiameter; in the case of a planet, take its horizontal parallax only.

*Apparent Altitude of the Moon.*—To the altitude given by the sextant apply the index correction of the instrument and subtract the dip of the horizon (Table 14).[a] If the lower limb is observed, add the semidiameter and augmentation (Table 18); if the upper limb is observed, subtract the augmented semidiameter. The result is the apparent altitude of the moon's center, denoted " ☾'s *App. Alt.*"

*Apparent Altitude of the Sun, Planet, or Star.*—To the observed altitude apply the index correction of the sextant, and subtract the dip (Table 14); and if the sun is used, add its semidiameter when the lower limb is observed, or subtract it when the upper limb is observed. The result is the apparent altitude required, denoted by "☉'s or ✳'s *App. Alt.*"

*Apparent Distance.*—First, when the sun is used, to the observed distance (corrected for index error when necessary) add the moon's augmented semidiameter and the sun's semidiameter; second, when a planet or star is used, add the moon's augmented semidiameter if its nearer limb is observed, but subtract it if its farther limb is observed. The result is "*App. Dist.*"

*Moon's Reduced Parallax and Refraction.*—Enter Table 19 with the latitude of the place of observation and the moon's horizontal parallax, and take out the correction, which add to the horizontal parallax. Call the result the moon's reduced parallax, or "☾'s *Red. P.*"

Enter Table I with the moon's apparent altitude, and take out the mean reduced refraction, and apply to this mean refraction the corrections given in Tables 21 and 22, adding or subtracting these corrections according to the directions in the tables. The result is the moon's reduced refraction, or "☾'s *Red. R.*"

---

[a] The tables designated by their numbers in Arabic notation are to be found in Part II. The tables contained in this Appendix, which are for exclusive use with lunar-distance observations, are denoted by Roman numbers.

Subtract the "$\mathbb{C}$'s Red. R." from the "$\mathbb{C}$'s Red. P." and mark the result as "$\mathbb{C}$'s *Red. P. and R.*"

*Reduced Parallax and Refraction of Sun, Planet, or Star.*[a]—With the apparent altitude of the sun, planet, or star, take from Table I the mean reduced refraction, which correct by Tables 21 and 22. If the sun is observed, subtract its horizontal parallax (which may always be taken at 8″.5) from its reduced refraction, and mark the result as "$\odot$'s *Red. P. and R.*" If a planet is observed subtract its horizontal parallax, and mark the result as "$*$'s *Red. P. and R.*" If a star is observed, its reduced refraction is at once the required "$*$'s *Red. P. and R.*"

COMPUTATION OF THE TRUE DISTANCE.—Take from Tables II, III, IV, and V respectively the four logarithms A, B, C, D,[b] and place these logarithms each at the head of a column, marking the columns A, B, C, and D; then put the—

log of $\mathbb{C}$'s Red. P. and R. (Table IX) in columns A and B.
log of $\odot$'s or $*$'s Red. P. and R. (Table IX) in columns C and D.
log sin $\mathbb{C}$'s App. Alt. (Table 44) in columns A and D.
log sin $\odot$'s or $*$'s App. Alt. (Table 44) in columns B and C.
log cot App. Dist. (Table 44) in columns A and C.
log cosec App. Dist. (Table 44) in columns B and D.

The sum of the four logs in Col. A is the log (Table IX) of the *First Part of $\mathbb{C}$'s Correction*, which is to be marked $+$ when the app. dist. is less than 90°, but $-$ when the app. dist. is greater than 90°.

The sum of the four logs in Col. B is the log (Table IX) of the *Second Part of $\mathbb{C}$'s Correction*, which is always to be marked $-$.

The sum of the four logs in Col. C is the log (Table IX) of the *First Part of the $\odot$'s or $*$'s Correction*, which is to be marked $-$ when the app. dist. is less than 90°, but $+$ when the app. dist. is greater than 90°.

The sum of the four logs in Col. D is the log (Table IX) of the *Second part of the $\odot$'s or $*$'s Correction*, which is always to be marked $+$.

Combine the first and second parts of the $\mathbb{C}$'s correction according to the signs prefixed; that is, take their *sum* if they have the *same* sign, but their *difference* if they have *different* signs, and prefix the sign of the greater to the result, which call "$\mathbb{C}$'s *whole correction.*"

In the same manner form the "$\odot$'s or $*$'s *whole correction.*"

*First Correction of Distance.*—Combine the $\mathbb{C}$'s *whole corr.* and the $\odot$'s or $*$'s *whole corr.*, according to their signs; the result is the *First Correction of Distance*, which is to be added to or subtracted from the apparent distance, according as its sign is $+$ or $-$.

*Second Correction of Distance.*—Enter Table VI with the Apparent Distance and the First Correction of Distance, and take out the *Second Correction of Distance*, which is to be applied to the distance according to the directions in the side columns of the Table.

*Correction for the Elliptical Figure of the Moon's Disk, or Contraction of the Moon's Semi-diameter.*—Enter Table VII A with the $\mathbb{C}$'s App. Alt. and $\mathbb{C}$'s Red. P. and R., and take out the number. With this number and the $\mathbb{C}$'s whole correction enter Table VII B and take out the required *contraction*, which is to be *added* to the app. dist. when the *farther* limb is observed, but *subtracted* when the *nearer* limb is observed.

*Correction for the Elliptical Figure of the Sun's Disk, or Contraction of the Sun's Semi-diameter.*—Enter Table VIII A with the $\odot$'s App. Alt. and $\odot$'s Red. P. and R., and take out the number. With this number and the $\odot$'s whole corr. enter Table VIII B and take out the required *contraction*, which is always to be *subtracted* from the distance (the *nearer* limb of the sun being always observed).

*Correction for Compression, or for the Spheroidal Figure of the Earth.*—Take from the Nautical Almanac for the Greenwich date the declinations of the bodies to the nearest whole degree. With the moon's declination and apparent distance, take from Table XI A the *first part of N*, and mark it with the sign in the table if the declination is *North;* but if the declination is *South*, change the sign from $+$ to $-$ or from $-$ to $+$. With the sun's or star's declination and the apparent distance take from Table XI B the *second part of N*, giving it the same sign as the declination. Take the sum, or *difference*, of the two parts, according as their signs are *same* or *different*, and to the resulting number prefix the sign of the greater. The logarithm of this number of seconds, taken from Table IX, with its sign prefixed, is the required log N. To log N add the log sine of the latitude of the place of observation; the sum is the log (Table IX) of the required *correction for compression*. In north latitude *add* this correction if log N is $+$, or *subtract* it if log N is $-$; in south latitude *subtract* the correction when log N is $+$, and *add* it when log N is $-$.

All these corrections being applied to the Apparent Distance, the result is the *True Distance*.

To FIND THE GREENWICH TIME.—Find in the Nautical Almanac the two distances between which the true distance falls. Take out the first of these, together with the Prop. Log following it, and the hours of Greenwich time over it. Find the difference between the distance taken from the Almanac and the true distance, and to the log of this difference (Table IX) *add* the Prop. Log from the Almanac; the sum is the log (Table IX) of an interval of time to be added to the hours of Greenwich time taken from the Almanac. The result is the *approximate* Greenwich time.

To correct this Greenwich time, take the difference between the two Prop. Logs in the Almanac which stand against the two distances between which the true distance falls. With this difference and the interval of time just found enter Table X and take out the seconds, which are to be *added* to the approximate Greenwich time when the Prop. Logs are *decreasing*, but *subtracted* when the Prop. Logs are *increasing*. The result is the *true Greenwich time*.

By comparing with this the local mean time the longitude will be found; or, if testing the time shown by chronometer, the difference between the true Greenwich time and the time shown by the chronometer is the error of the chronometer as determined by the lunar observation.

---

[a] The parallax of a star being zero, its "reduced parallax and refraction" become, of course, merely its "reduced refraction;" but as no mistake can arise from marking it as "$*$'s Red. P. and R.," this designation has been retained in order to give simplicity and uniformity at once to the rules and the tables.

[b] No interpolation is necessary in taking out these logarithms.

DEGREE OF DEPENDENCE.—If the error thus determined agrees with that deduced by means of the rate and original error, it may be accepted as a confirmation of the rate of the chronometer; if otherwise, more or less doubt is thrown upon the chronometer, according to the degree of accuracy of the lunar observation itself. An error of 10″ in the measurement of the distance produces about 20ˢ error in the Greenwich time; and since, even with the best observers, a single set of distances is subject to a possible error of 10″, it may be well to consider the chronometer as still to be trusted so long as it does not differ from the lunar by more than 20ˢ. Since, however, so much depends upon skill in measuring the distance, the observer can only form a correct judgment of the degree of dependence to be placed upon his own observations by repeated trials and a careful comparison of his several results.

EXAMPLE: In Lat. 35° 30′ N., Long. 30° W., by account, at the local mean time, 1855, September 6, 18ʰ 8ᵐ 0ˢ, the observed distance of ⊙'s and ☾'s nearer limbs was 43° 52′ 10″; observed alt. ☾, 49° 32′ 50″; observed alt. ⊙, 5° 27′ 10″; barometer, 29ⁱⁿ. 1; thermometer, 75°; height of the eye above the sea, 20ft; I. C., 0′ 00″; required the longitude.

*Preparation of the Data.*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| L. M. T., Sept. 6, | 18ʰ08ᵐ | ☾'s S. D., | | 14′ 50″.0 | ☾'s Par., N. A., | | 54′ 19″.4 |
| Long., D. R., | + 2 00 | Aug. Table 18, | + | 11 .2 | Aug., Table 19, | + | 3 .6 |
| G. M. T., approx., | 20 08 | ☾'s Aug. S. D, | | 15 01 .2 | ☾'s Red. P., | | 54 23 .0 |
| Obs. Alt. ☾, | 49° 32′ 50″ | Obs. Alt. ⊙, | | 5° 27′ 10″ | Obs. Dist. ⊙\| \|☾, | | 43° 52′ 10″ |
| Dip, Table 14, | — 4 23 | Dip, | — | 4 23 | ☾'s Aug. S. D., | + | 15 01 |
| ☾'s Aug. S. D., | + 15 01 | ⊙'s S. D., . | + | 15 55 | ⊙'s S. D., . | + . | 15 55 |
| ☾'s App. Alt., | 49 43 28 | ⊙'s App. Alt., | | 5 38 42 | App. Dist., | | 44 23 06 |
| ☾'s Red. R., Table I, | 1′ 16″ | ⊙'s Red R., Table I, | | 8′ 57″ | ☾'s Dec., N. A., | | 25° N. |
| Bar. 29ⁱⁿ.1, Table 21, | — 3 | Bar., Table 21, | — | 16 | ⊙'s Dec., N. A., | | 6° N. |
| Ther. 75°, Table 22, | — 4 | Ther., Table 22, | — | 28 | | | |
| ☾'s Red. R., | 1 09 | ⊙'s Red. R., | | 8 13 | | | |
| ☾'s Red. P., | 54 23 | ⊙'s Par., | | 8 | | | |
| ☾'s Red. P. and R., | 53 14 | ⊙'s Red. P. and R., | | 8 05 | | | |

*Computation of the True Distance.*

| A. | | C. | |
|---|---|---|---|
| log A, Table II, | 0.0021 | log C, Table IV, | 9.9949 |
| log ☾'s Red. P. and R., | 3.5043 | log ⊙'s Red. P. and R., | 2.6857 |
| log sin ☾'s App. Alt., | 9.8825 | log sin ⊙'s App. Alt., | 8.9929 |
| log cot App. Dist., | 0.0093 | log cot App. Dist., | 0.0093 |
| ⎰log, Table IX, | 3.3982 | ⎰log, Table IX, | 1.6828 |
| ⎱1st Part ☾'s corr., | +41′ 42″ | ⎱1st Part ⊙'s corr., | −0′ 48″ |

| B. | | D. | |
|---|---|---|---|
| log B, Table III, | 9.9951 | log D, Table V, | 9.9992 |
| log ☾'s Red. P. and R., | 3.5043 | log ⊙'s Red. P. and R., | 2.6857 |
| log sin ⊙'s App. Alt., | 8.9929 | log sin ☾'s App. Alt., | 9.8825 |
| log cosec App. Dist., | 0.1552 | log cosec App. Dist., | 0.1552 |
| ⎰log, Table IX, | 2.6475 | ⎰log, Table IX, | 2.7226 |
| ⎱2d Part ☾'s corr., | − 7′ 24″ | ⎱2d Part ⊙'s corr., | +8′ 48″ |
| ☾'s whole corr., | +34′ 18″ | ⊙'s whole corr., | +8′ 00″ |

| | | |
|---|---|---|
| App. Dist., | | 44° 23′ 06″ |
| 1st Corr., | + | 42 18 |
| 2d Corr., Table VI, | — | 16 |
| Contraction of ☾'s S. D., Table VII, ⎰ | | 0 |
| Contraction of ⊙'s S.D., Table VIII, ⎰ | — | 20, |
| Corr. for Comp. | — | 4 |
| True Distance, | | 45 04 44 |

log N, Tabs. XI and IX, (−)0.845
log sin Lat., +35° 30′, (+)9.764

⎰log, Table IX,    (−)0.609
⎱Corr. for Compression, − 4″

*Extract from Nautical Almanac, September, 1855.*

GREENWICH MEAN TIME: LUNAR DISTANCES.

| Day of the month. | Star's name and position. | Midnight. | P. L. of Diff. | XV$^h$. | P. L. of Diff. | XVIII$^h$. | P. L. of Diff. | XXI$^h$. | P. L. of Diff. |
|---|---|---|---|---|---|---|---|---|---|
| 6 | SUN　　E. | 48° 46′ 55″ | 3422 | 47° 25′ 3″ | 3427 | 46° 3′ 17″ | 3433 | 44° 41′ 38″ | 3438 |

*Computation of Greenwich Mean Time.*

| | | | |
|---|---|---|---|
| True Distance, | 45° 04′ 44″ | | |
| Distance, N. A., at XVIII$^h$, | 46　03　17 | P. L., 0.3433 | Diff. P. logs + 5 |
| Difference, | 58　33 | log, Table IX, 3.5457 | |
| Approximate interval, | 2$^h$ 09$^m$ 04$^s$ | log, Table IX, 3.8890 | |
| Add— | 18 | | |
| Approx. G. M. T., | 20　09　04 | | |
| Corr., Table X, | —　　　2 | | |
| True G. M. T., | 20　09　02 | | |
| L. M. T., | 18　08　00 | | |
| Longitude, | + 2　01　02 = 30° 15′ 30″ W. | | |

EXAMPLE: In Lat. 55° 20′ S., Long. 120° 25′ W., by account, on August 29, 1855, at 9$^h$ 40$^m$ 00$^s$ p. m., local mean time, the following distance and altitudes were found, being the mean of six observations corrected for index error. Observed distance of Fomalhaut and moon's farther limb, 46° 30′ 23″; observed alt. ☾, 6° 26′ 10″; observed alt. Fomalhaut, 52° 34′ 40″; barometer, 31$^{in}$; thermometer, 20°; height of the eye above the sea, 18$^{ft}$.

*Preparation of the Data.*

| | | | | | |
|---|---|---|---|---|---|
| L. M. T., August 29, | 9$^h$ 40$^m$ 00$^s$ | ☾'s S. D., Naut. Al., | 16′ 26″.3 | ☾'s Par., N. A., | 60′ 11″.8 |
| Long. by D. R., | + 8　01　40 | Aug., Table 18, + | 2 .0 | Aug., Table 19, + | 8 .3 |
| Approx. G. M. T., | 17　41　40 | ☾'s aug S. D., | 16　28 .3 | ☾' Red P., | 60　20 .1 |
| Obs. alt. ☾ | 6° 26′ 10″ | Obs. alt. ✳, | 52° 34′ 40″ | Obs. Dist. ✳ ⎮☾, | 46° 30′ 23″ |
| Dip, | —　4　09 | Dip, | —　4　09 | ☾'s aug., S. D., | — 16　28 |
| ☾'s aug. S. D., | + 16　28 | | | App. Dist., | 46　13　55 |
| ☾'s App. Alt., | 6　38 ·29 | ✳'s App. Alt., | 52　30　31· | | |
| ☾'s Red R., Table I, | 7′ 48″ | ✳'s Red. R., Table I, | 1′ 13″ | ☾'s Dec., N. A., | 4° N. |
| Bar., Table 21, + | 16 | Bar., Table 21, + | 2 | ✳'s Dec., N. A., | 30° S. |
| Ther., Table 22, + | 32 | Ther., Table 22, + | 5 | | |
| ☾'s Red R., | 8　36 · | ✳'s Red. R., | 1　20 | | |
| ☾'s Red. P., | 60　20 | ✳'s Red P., | 0 | | |
| ☾'s Red. P. and R., | 51　44 | ✳'s Red. P. and R., | 1　20 | | |

*Computation of the True Distance.*

A.

| | |
|---|---|
| log A, Table II, | 0.0274 |
| log ☾'s Red. P. and R., | 3.4919 |
| log sin ☾'s App. Alt., | 9.0632 |
| log cot App. Dist., | 9.9813 |

| | |
|---|---|
| {log, Table IX, | 2.5638 |
| {1st Part ☾'s corr., + | 6' 06'' |

B.

| | |
|---|---|
| log B, Table III, | 0.0001 |
| log ☾'s Red. P. and R., | 3.4919 |
| log sin ✳'s App. Alt., | 9.8995 |
| log cosec App. Dist., | 0.1414 |

| | |
|---|---|
| {log, Table IX, | 3.5329 |
| {2d Part ☾'s corr., − | 56' 51'' |
| ☾'s whole corr., − | 50  45 |

| | | |
|---|---|---|
| log N, Tabs. XI and | (−) | 1.230 |
| IX, | | |
| log sin Lat., −55°, | (−) | 9.913 |

| | | |
|---|---|---|
| {log Table IX, | (+) | 1.143 |
| {Corr. for Comp., | + | 14'' |

C.

| | |
|---|---|
| log C, Table IV, | 9.9999 |
| log ✳'s Red. P. and R., | 1.9031 |
| log sin ✳'s App. Alt., | 9.8995 |
| log cot App. Dist., | 9.9813 |

| | |
|---|---|
| {log, Table IX, | 1.7838 |
| {1st Part ✳'s corr., − | 1' 01'' |

D.

| | |
|---|---|
| log D, Table V, | 0.0267 |
| log ✳'s Red. P. and R., | 1.9031 |
| log sin ☾'s App. Alt., | 9.0632 |
| log cosec App. Dist., | 0.1414 |

| | |
|---|---|
| {log, Table IX, | 1.1344 |
| {2d Part ✳'s corr., + | 0' 14'' |
| ✳'s whole corr., − | 0  47 |

| | | | |
|---|---|---|---|
| App. Dist., | 46° | 13' | 55'' |
| 1st corr., | − | 51 | 32 |
| 2d corr., Table VI, | − | | 22 |
| Contraction of ☾'s } | + | | 17 |
| S. D., Table VII, } | | | |
| Corr. for Comp., | + | | 14 |
| True Distance, | 45 | 22 | 32 |

*Extract from Nautical Almanac, August, 1855.*

GREENWICH MEAN TIME: LUNAR DISTANCES.

| Day of the month. | Star's name and position. | Midnight. | P. L. of Diff. | XV h. | P. L. of Diff. | XVIII h. | P. L. of Diff. | XXI h. | P. L. of Diff. |
|---|---|---|---|---|---|---|---|---|---|
| 29 | Fomalhaut W. | 42° 11' 34'' | 2535 | 43° 51' 59'' | 2527 | 45° 32' 35'' | 2521 | 47° 13' 19'' | 2516 |

*Computation of Greenwich Mean Time.*

| | | | | |
|---|---|---|---|---|
| True Distance, | 45° 22' 32'' | | | |
| Dist., N. A., at XV h, | 43  51  59 | P. L., | 0.2527 | Diff. P. logs − 6 |
| Difference, | 1  30  33 | log, Table IX, | 3.7350 | |
| Approx. interval, | 2ʰ 42ᵐ 01ˢ | log, Table IX, | 3.9877 | |
| Add— | 15 | | | |
| Approx. G. M. T., | 17  42  01 | | | |
| Corr., Table X, | +   01 | | | |
| True G. M. T., | 17  42  02 | | | |
| L. M. T., | 9  40  00 | | | |
| Long., | + 8  02  02 | = 120° 30' 30'' W. | | |

METHOD OF TAKING A LUNAR OBSERVATION BY ONE OBSERVER.—Three observers are required to make the necesssary observations for determining the longitude—one to measure the distance of the bodies, and the others to take the altitudes. In case of not having a sufficient number of instruments or observers to take the altitudes, the latter may be calculated, there being given the latitude of the place, the time, the right ascensions, and the declinations of the objects. These calculations are long, however, especially in the case of the moon, and a considerable degree of accuracy is required in finding from the Nautical Almanac the moon's right ascension and declination, which must be liable to some error on account of the uncertainty of the ship's longitude. The following method of obtaining those altitudes is far more simple, and sufficiently accurate. This method depends on the supposition that the altitudes increase or decrease uniformly.

Before measuring the distance of the bodies, take their altitudes, and note the times by a chronometer; then measure the distance and note the time (or measure a number of distances, and note the corresponding times, and take the means); after having measured the distances, again measure the altitudes, and note the times; then, from the two observed altitudes of either of the objects, the required altitude of that object may be found from the following formula, which is based upon simple proportion:

$$x = \frac{d \times e}{t},$$

where $x$ = change of altitude, in minutes, between first altitude and time of measuring the lunar distance, being positive or negative according as body is rising or falling;

$d$ = difference between first and second altitudes, in minutes;

$e$ = time, in seconds, between first altitude and lunar observations; and

$t$ = time in seconds, between first and second altitudes.

The change of altitude thus deduced, applied with proper sign to the first altitude, gives the altitude at time of observing the lunar distance.

EXAMPLE: Suppose the distances and altitudes of the sun and moon were observed, as in the following table; it is required to find the altitudes at the time of measuring the mean distance.

| Times by chro-nometer. | Lunar dis-tance. | Times by chro-nometer. | Obs. alt. ☾'s L. L. | Times by chro-nometer. | Obs. alt. ☉'s L. L. |
|---|---|---|---|---|---|
| 2ʰ 03ᵐ 20ˢ | 40° 00′ 00″ | 2ʰ 02 ᵐ00ˢ | 20° 46′ | 2ʰ 02ᵐ 30ˢ | 40° 20′ |
| 2  04  20 | 40  00  30 | 2  06  10 | 21  20 | 2  07  00 | 39  12 |
| 2  05  50 | 40  01  30 | | | | |
| Mean, 2  04  30 | 40  00  40 | $t,\begin{cases}4 & 10 \\ 250ˢ\end{cases}$ | $d,\quad 34$ | $t,\begin{cases}4 & 30 \\ 270ˢ\end{cases}$ | $d,\begin{cases}1 & 08 \\ 68′\end{cases}$ |

For ☾.

| | | For ☉. | |
|---|---|---|---|
| Time of lunar obs., | 2ʰ 04ᵐ 30ˢ | Time of lunar obs., | 2ʰ 04ᵐ 30ˢ |
| Time of 1st alt., | 2  02  00 | Time of 1st alt., | 2  02  30 |
| $e,$ | $\begin{cases}2 & 30 \\ 150ˢ\end{cases}$ | $e,$ | $\begin{cases}2 & 00 \\ 120ˢ\end{cases}$ |
| $x = + \dfrac{34 \times 150}{250} = +20′.4 = +20′\,24″$ | | $x = - \dfrac{68 \times 120}{270} = -30′.2 = -30′\,12″$ | |
| First altitude, | 20° 46′ 00″ | First altitude, | 40° 20′ 00″ |
| $x,$ | $+\quad 20\ 24$ | $x,$ | $-\quad 30\ 12$ |
| Required altitude, | 21  06  24 | Required altitude, | 39  49  48 |

To obtain the altitudes by calculation the following formulæ may be employed:

$$\tan A = \tan d \sec t;$$

$$\sin h = \frac{\cos (A - L) \sin d}{\sin A};$$

in which $d$ is the declination; $t$, the hour angle; $L$, the latitude; $h$, the *true* altitude of the center of the object; $A$, an arc which has the same name or sign as the declination and is numerically in the same quadrant as $t$. In the solution, strict regard must be had for the signs.

EXAMPLE: Required the apparent altitude of the sun's center on December 22, 1879, in Lat. 48° 23′ N., Long. 60° W., at 10ʰ 01ᵐ 14ˢ a. m., app. time.

| | | | | |
|---|---|---|---|---|
| L. A. T., December 21, | 22ʰ 01ᵐ 14ˢ | $t,$ | 1ʰ 58ᵐ 46ˢ | |
| Long., | + 4  00  00 | ☉'s Dec., | 23° 27′ 16″ S. | |
| G. A. T., December 22, | 2  01  14 | | | |

| $t$ | 29° 41′ 30″ | sec | 0.06113 | | |
|---|---|---|---|---|---|
| $d$ | − 23 . 27  16 | tan (−) 9.63735 | | sin  (−) 9.59991 | |
| $A$ | − 26  32  20 | tan (−) 9.69848 | | cosec (−) 0.34989 | |
| $L$ | + 48  23  00 | | | | |
| $A - L$ | − 74  55  20 | | | cos  (+) 9.41520 | |
| $h$ | 13  23  58 | | | sin  (+) 9.36500 | |
| ref. −par. + | 3  50 | | | | |
| App. alt. | 13  27  48 | | | | |

## Mean Reduced Refraction for Lunars.

### Barometer 30 inches.   Fahrenheit's Thermometer 50°.

| Apparent altitude. | Reduced refraction. | Diff. to 1'. | Apparent altitude. | Reduced refraction. | Apparent altitude. | Reduced refraction. | Apparent altitude. | Reduced refraction. |
|---|---|---|---|---|---|---|---|---|
| ° ' | ' '' | '' | ° ' | ' '' | ° ' | ' '' | ° ' | ' '' |
| 5 0 | 9 54.2 | 1.6 | 10 0 | 5 24.1 | 15 0 | 3 41.7 | 27 0 | 2 7.8 |
| 5 | 9 46.3 | 1.5 | 5 | 5 21.6 | 10 | 3 39.4 | 27 30 | 2 5.7 |
| 10 | 9 38.6 | 1.5 | 10 | 5 19.2 | 20 | 3 37.1 | 28 0 | 2 3.7 |
| 15 | 9 31.0 | 1.5 | 15 | 5 16.8 | 30 | 3 34.9 | 28 30 | 2 1.7 |
| 20 | 9 23.7 | 1.4 | 20 | 5 14.4 | 40 | 3 32.7 | 29 0 | 1 59.8 |
| 25 | 9 16.5 | 1.4 | 25 | 5 12.1 | 50 | 3 30.6 | 29 30 | 1 58.0 |
| 5 30 | 9 9.5 | 1.4 | 10 30 | 5 9.8 | 16 0 | 3 28.5 | 30 0 | 1 56.2 |
| 35 | 9 2.7 | 1.3 | 35 | 5 7.5 | 10 | 3 26.5 | 30 30 | 1 54.5 |
| 40 | 8 56.0 | 1.3 | 40 | 5 5.3 | 20 | 3 24.5 | 31 0 | 1 52.8 |
| 45 | 8 49.5 | 1.3 | 45 | 5 3.1 | 30 | 3 22.6 | 31 30 | 1 51.2 |
| 50 | 8 43.1 | 1.2 | 50 | 5 0.9 | 40 | 3 20.7 | 32 0 | 1 49.7 |
| 55 | 8 36.9 | 1.2 | 55 | 4 58.8 | 50 | 3 18.8 | 32 30 | 1 48.2 |
| 6 0 | 8 30.9 | 1.2 | 11 0 | 4 56.7 | 17 0 | 3 16.9 | 33 0 | 1 46.7 |
| 5 | 8 24.9 | 1.2 | 5 | 4 54.6 | 10 | 3 15.1 | 33 30 | 1 45.3 |
| 10 | 8 19.1 | 1.1 | 10 | 4 52.5 | 20 | 3 13.4 | 34 0 | 1 44.0 |
| 15 | 8 13.4 | 1.1 | 15 | 4 50.5 | 30 | 3 11.6 | 34 30 | 1 42.7 |
| 20 | 8 7.8 | 1.1 | 20 | 4 48.5 | 40 | 3 9.9 | 35 0 | 1 41.4 |
| 25 | 8 2.4 | 1.1 | 25 | 4 46.6 | 50 | 3 8.2 | 35 30 | 1 40.2 |
| 6 30 | 7 57.0 | 1.0 | 11 30 | 4 44.6 | 18 0 | 3 6.6 | 36 0 | 1 39.0 |
| 35 | 7 51.8 | 1.0 | 35 | 4 42.7 | 10 | 3 5.0 | 36 30 | 1 37.8 |
| 40 | 7 46.7 | 1.0 | 40 | 4 40.8 | 20 | 3 3.4 | 37 0 | 1 36.7 |
| 45 | 7 41.7 | 1.0 | 45 | 4 38.9 | 30 | 3 1.8 | 37 30 | 1 35.6 |
| 50 | 7 36.7 | 1.0 | 50 | 4 37.1 | 40 | 3 0.3 | 38 0 | 1 34.5 |
| 55 | 7 31.9 | 0.9 | 55 | 4 35.3 | 50 | 2 58.8 | 38 30 | 1 33.5 |
| 7 0 | 7 27.2 | 0.9 | 12 0 | 4 33.5 | 19 0 | 2 57.3 | 39 0 | 1 32.5 |
| 5 | 7 22.6 | 0.9 | 5 | 4 31.7 | 10 | 2 55.9 | 39 30 | 1 31.5 |
| 10 | 7 18.0 | 0.9 | 10 | 4 30.0 | 20 | 2 54.4 | 40 0 | 1 30.6 |
| 15 | 7 13.6 | 0.9 | 15 | 4 28.3 | 30 | 2 53.0 | 40 30 | 1 29.6 |
| 20 | 7 9.2 | 0.9 | 20 | 4 26.6 | 40 | 2 51.6 | 41 0 | 1 28.7 |
| 25 | 7 4.9 | 0.8 | 25 | 4 24.9 | 50 | 2 50.3 | 41 30 | 1 27.8 |
| 7 30 | 7 0.8 | 0.8 | 12 30 | 4 23.2 | 20 0 | 2 49.0 | 42 0 | 1 27.0 |
| 35 | 6 56.6 | 0.8 | 35 | 4 21.6 | 10 | 2 47.6 | 42 30 | 1 26.2 |
| 40 | 6 52.6 | 0.8 | 40 | 4 20.0 | 20 | 2 46.4 | 43 0 | 1 25.4 |
| 45 | 6 48.6 | 0.8 | 45 | 4 18.4 | 30 | 2 45.1 | 43 30 | 1 24.6 |
| 50 | 6 44.8 | 0.8 | 50 | 4 16.8 | 40 | 2 43.8 | 44 0 | 1 23.8 |
| 55 | 6 40.9 | 0.7 | 55 | 4 15.2 | 50 | 2 42.6 | 44 30 | 1 23.1 |
| 8 0 | 6 37.2 | 0.7 | 13 0 | 4 13.7 | 21 0 | 2 41.4 | 45 0 | 1 22.4 |
| 5 | 6 33.5 | 0.7 | 5 | 4 12.2 | 10 | 2 40.2 | 46 0 | 1 21.0 |
| 10 | 6 29.9 | 0.7 | 10 | 4 10.7 | 20 | 2 39.0 | 47 0 | 1 19.6 |
| 15 | 6 26.3 | 0.7 | 15 | 4 9.2 | 30 | 2 37.9 | 48 0 | 1 18.4 |
| 20 | 6 22.8 | 0.7 | 20 | 4 7.7 | 40 | 2 36.7 | 49 0 | 1 17.2 |
| 25 | 6 19.4 | 0.7 | 25 | 4 6.3 | 50 | 2 35.6 | 50 0 | 1 16.0 |
| 8 30 | 6 16.0 | 0.7 | 13 30 | 4 4.8 | 22 0 | 2 34.5 | 51 0 | 1 15.0 |
| 35 | 6 12.7 | 0.6 | 35 | 4 3.4 | 10 | 2 33.4 | 52 0 | 1 13.9 |
| 40 | 6 9.5 | 0.6 | 40 | 4 2.0 | 20 | 2 32.4 | 53 0 | 1 13.0 |
| 45 | 6 6.3 | 0.6 | 45 | 4 0.6 | 30 | 2 31.3 | 54 0 | 1 12.0 |
| 50 | 6 3.1 | 0.6 | 50 | 3 59.3 | 40 | 2 30.3 | 55 0 | 1 11.1 |
| 55 | 6 0.0 | 0.6 | 55 | 3 57.9 | 50 | 2 29.2 | 56 0 | 1 10.3 |
| 9 0 | 5 57.0 | 0.6 | 14 0 | 3 56.6 | 23 0 | 2 28.2 | 57 0 | 1 9.5 |
| 5 | 5 54.0 | 0.6 | 5 | 3 55.3 | 20 | 2 26.3 | 58 0 | 1 8.7 |
| 10 | 5 51.1 | 0.6 | 10 | 3 54.0 | 40 | 2 24.4 | 59 0 | 1 8.0 |
| 15 | 5 48.2 | 0.6 | 15 | 3 52.7 | 24 0 | 2 22.5 | 60 0 | 1 7.3 |
| 20 | 5 45.3 | 0.6 | 20 | 3 51.4 | 20 | 2 20.7 | 62 0 | 1 6.0 |
| 25 | 5 42.5 | 0.5 | 25 | 3 50.1 | 40 | 2 18.9 | 64 0 | 1 4.9 |
| 9 30 | 5 39.8 | 0.5 | 14 30 | 3 48.9 | 25 0 | 2 17.2 | (6 0 | 1 3.8 |
| 35 | 5 37.0 | 0.5 | 35 | 3 47.6 | 20 | 2 15.5 | 68 0 | 1 2.9 |
| 40 | 5 34.4 | 0.5 | 40 | 3 46.4 | 40 | 2 13.9 | 70 0 | 1 2.0 |
| 45 | 5 31.7 | 0.5 | 45 | 3 45.2 | 26 0 | 2 12.3 | 73 0 | 1 1.0 |
| 50 | 5 29.2 | 0.5 | 50 | 3 44.0 | 20 | 2 10.8 | 76 0 | 1 0.1 |
| 55 | 5 26.6 | 0.5 | 55 | 3 42.8 | 40 | 2 9.3 | 80 0 | 0 59.2 |
| 10 0 | 5 24.1 | | 15 0 | 3 41.7 | 27 0 | 2 7.8 | 90 0 | 0 58.3 |

# APPENDIX V: TABLE II.

Log. A, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | Reduced parallax and refraction of moon. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 41' | 42' | 43' | 44' | 45' | 46' | 47' | 48' | 49' | 50' | 51' | 52' | 53' | 54' | 55' |
| 5° 0' | .0288 | 0295 | 0301 | 0308 | 0315 | 0321 | 0328 | 0335 | 0341 | 0348 | 0355 | 0361 | 0368 | | |
| 2 | .0286 | 0293 | 0299 | 0306 | 0313 | 0319 | 0326 | 0333 | 0339 | 0346 | 0352 | 0359 | 0366 | | |
| 4 | .0284 | 0291 | 0297 | 0304 | 0311 | 0317 | 0324 | 0330 | 0337 | 0344 | 0350 | 0357 | 0363 | | |
| 6 | .0282 | 0289 | 0296 | 0302 | 0309 | 0315 | 0322 | 0328 | 0335 | 0341 | 0348 | 0354 | 0361 | | |
| 8 | .0281 | 0287 | 0294 | 0300 | 0307 | 0313 | 0320 | 0326 | 0333 | 0339 | 0346 | 0352 | 0359 | | |
| 5 10 | .0279 | 0285 | 0292 | 0298 | 0305 | 0311 | 0318 | 0324 | 0331 | 0337 | 0344 | 0350 | 0356 | | |
| 12 | .0277 | 0284 | 0290 | 0296 | 0303 | 0309 | 0316 | 0322 | 0329 | 0335 | 0341 | 0348 | 0354 | | |
| 14 | .0275 | 0282 | 0288 | 0295 | 0301 | 0307 | 0314 | 0320 | 0327 | 0333 | 0339 | 0346 | 0352 | | |
| 16 | .0274 | 0280 | 0286 | 0293 | 0299 | 0306 | 0312 | 0318 | 0325 | 0331 | 0337 | 0344 | 0350 | | |
| 18 | .0272 | 0278 | 0285 | 0291 | 0297 | 0304 | 0310 | 0316 | 0323 | 0329 | 0335 | 0341 | 0348 | | |
| 5 20 | .0270 | 0277 | 0283 | 0289 | 0296 | 0302 | 0308 | 0314 | 0321 | 0327 | 0333 | 0339 | 0346 | | |
| 22 | .0269 | 0275 | 0281 | 0288 | 0294 | 0300 | 0306 | 0313 | 0319 | 0325 | 0331 | 0337 | 0344 | | |
| 24 | .0267 | 0273 | 0280 | 0286 | 0292 | 0298 | 0304 | 0311 | 0317 | 0323 | 0329 | 0335 | 0341 | | |
| 26 | .0265 | 0272 | 0278 | 0284 | 0290 | 0296 | 0303 | 0309 | 0315 | 0321 | 0327 | 0333 | 0339 | 0346 | |
| 28 | .0264 | 0270 | 0276 | 0282 | 0289 | 0295 | 0301 | 0307 | 0313 | 0319 | 0325 | 0331 | 0337 | 0344 | |
| 5 30 | .0262 | 0268 | 0275 | 0281 | 0287 | 0293 | 0299 | 0305 | 0311 | 0317 | 0323 | 0329 | 0335 | 0342 | |
| 32 | .0261 | 0267 | 0273 | 0279 | 0285 | 0291 | 0297 | 0303 | 0309 | 0315 | 0321 | 0327 | 0334 | 0340 | |
| 34 | .0259 | 0265 | 0271 | 0277 | 0283 | 0290 | 0296 | 0302 | 0308 | 0314 | 0320 | 0326 | 0332 | 0338 | |
| 36 | .0258 | 0264 | 0270 | 0276 | 0282 | 0288 | 0294 | 0300 | 0306 | 0312 | 0318 | 0324 | 0330 | 0336 | |
| 38 | | 0262 | 0268 | 0274 | 0280 | 0286 | 0292 | 0298 | 0304 | 0310 | 0316 | 0322 | 0328 | 0334 | |
| 5 40 | | 0261 | 0267 | 0273 | 0279 | 0285 | 0290 | 0296 | 0302 | 0308 | 0314 | 0320 | 0326 | 0332 | |
| 42 | | 0259 | 0265 | 0271 | 0277 | 0283 | 0289 | 0295 | 0301 | 0306 | 0312 | 0318 | 0324 | 0330 | |
| 44 | | 0258 | 0264 | 0270 | 0275 | 0281 | 0287 | 0293 | 0299 | 0305 | 0311 | 0316 | 0322 | 0328 | |
| 46 | | 0256 | 0262 | 0268 | 0274 | 0280 | 0286 | 0291 | 0297 | 0303 | 0309 | 0315 | 0320 | 0326 | |
| 48 | | 0255 | 0261 | 0267 | 0272 | 0278 | 0284 | 0290 | 0296 | 0301 | 0307 | 0313 | 0319 | 0324 | |
| 5 50 | | 0253 | 0259 | 0265 | 0271 | 0277 | 0282 | 0288 | 0294 | 0300 | 0305 | 0311 | 0317 | 0323 | |
| 52 | | 0252 | 0258 | 0264 | 0269 | 0275 | 0281 | 0287 | 0292 | 0298 | 0304 | 0309 | 0315 | 0321 | |
| 54 | | 0251 | 0256 | 0262 | 0268 | 0274 | 0279 | 0285 | 0291 | 0296 | 0302 | 0308 | 0313 | 0319 | |
| 56 | | 0249 | 0255 | 0261 | 0266 | 0272 | 0278 | 0283 | 0289 | 0295 | 0300 | 0306 | 0312 | 0317 | |
| 58 | | 0248 | 0254 | 0259 | 0265 | 0271 | 0276 | 0282 | 0287 | 0293 | 0299 | 0304 | 0310 | 0316 | |
| 6 0 | | 0247 | 0252 | 0258 | 0263 | 0269 | 0275 | 0280 | 0286 | 0291 | 0297 | 0303 | 0308 | 0314 | |
| 2 | | 0245 | 0251 | 0256 | 0262 | 0268 | 0273 | 0279 | 0284 | 0290 | 0295 | 0301 | 0307 | 0312 | |
| 4 | | 0244 | 0249 | 0255 | 0261 | 0266 | 0272 | 0277 | 0283 | 0288 | 0294 | 0299 | 0305 | 0310 | |
| 6 | | 0243 | 0248 | 0254 | 0259 | 0265 | 0270 | 0276 | 0281 | 0287 | 0292 | 0298 | 0303 | 0309 | |
| 8 | | 0241 | 0247 | 0252 | 0258 | 0263 | 0269 | 0274 | 0280 | 0285 | 0291 | 0296 | 0302 | 0307 | |
| 6 10 | | 0240 | 0246 | 0251 | 0256 | 0262 | 0267 | 0273 | 0278 | 0284 | 0289 | 0295 | 0300 | 0306 | |
| 12 | | 0239 | 0244 | 0250 | 0255 | 0261 | 0266 | 0271 | 0277 | 0282 | 0288 | 0293 | 0299 | 0304 | |
| 14 | | 0237 | 0243 | 0248 | 0254 | 0259 | 0265 | 0270 | 0275 | 0281 | 0286 | 0292 | 0297 | 0302 | |
| 16 | | 0236 | 0242 | 0247 | 0252 | 0258 | 0263 | 0269 | 0274 | 0279 | 0285 | 0290 | 0295 | 0301 | |
| 18 | | 0235 | 0240 | 0246 | 0251 | 0257 | 0262 | 0267 | 0273 | 0278 | 0283 | 0289 | 0294 | 0299 | |
| 6 20 | | 0234 | 0239 | 0245 | 0250 | 0255 | 0261 | 0266 | 0271 | 0276 | 0282 | 0287 | 0292 | 0298 | |
| 22 | | 0233 | 0238 | 0243 | 0249 | 0254 | 0259 | 0264 | 0270 | 0275 | 0280 | 0286 | 0291 | 0296 | |
| 24 | | 0231 | 0237 | 0242 | 0247 | 0253 | 0258 | 0263 | 0268 | 0274 | 0279 | 0284 | 0289 | 0295 | |
| 26 | | | 0236 | 0241 | 0246 | 0251 | 0257 | 0262 | 0267 | 0272 | 0277 | 0283 | 0288 | 0293 | |
| 28 | | | 0234 | 0240 | 0245 | 0250 | 0255 | 0260 | 0266 | 0271 | 0276 | 0281 | 0286 | 0292 | 0297 |
| 6 30 | | | 0233 | 0238 | 0244 | 0249 | 0254 | 0259 | 0264 | 0270 | 0275 | 0280 | 0285 | 0290 | 0295 |
| 32 | | | 0232 | 0237 | 0242 | 0248 | 0253 | 0258 | 0263 | 0268 | 0273 | 0278 | 0284 | 0289 | 0294 |
| 34 | | | 0231 | 0236 | 0241 | 0246 | 0251 | 0257 | 0262 | 0267 | 0272 | 0277 | 0282 | 0287 | 0292 |
| 36 | | | 0230 | 0235 | 0240 | 0245 | 0250 | 0255 | 0260 | 0266 | 0271 | 0276 | 0281 | 0286 | 0291 |
| 38 | | | 0229 | 0234 | 0239 | 0244 | 0249 | 0254 | 0259 | 0264 | 0269 | 0274 | 0279 | 0284 | 0290 |
| 6 40 | | | 0227 | 0232 | 0238 | 0243 | 0248 | 0253 | 0258 | 0263 | 0268 | 0273 | 0278 | 0283 | 0288 |
| 42 | | | 0226 | 0231 | 0236 | 0241 | 0246 | 0252 | 0257 | 0262 | 0267 | 0272 | 0277 | 0282 | 0287 |
| 44 | | | 0225 | 0230 | 0235 | 0240 | 0245 | 0250 | 0255 | 0260 | 0265 | 0270 | 0275 | 0280 | 0285 |
| 46 | | | 0224 | 0229 | 0234 | 0239 | 0244 | 0249 | 0254 | 0259 | 0264 | 0269 | 0274 | 0279 | 0284 |
| 48 | | | 0223 | 0228 | 0233 | 0238 | 0243 | 0248 | 0253 | 0258 | 0263 | 0268 | 0273 | 0278 | 0283 |
| 6 50 | | | 0222 | 0227 | 0232 | 0237 | 0242 | 0247 | 0252 | 0257 | 0262 | 0266 | 0271 | 0276 | 0281 |
| 52 | | | 0221 | 0226 | 0231 | 0236 | 0241 | 0246 | 0250 | 0255 | 0260 | 0265 | 0270 | 0275 | 0280 |
| 54 | | | 0220 | 0225 | 0230 | 0235 | 0239 | 0244 | 0249 | 0254 | 0259 | 0264 | 0269 | 0274 | 0279 |
| 56 | | | 0219 | 0224 | 0229 | 0233 | 0238 | 0243 | 0248 | 0253 | 0258 | 0263 | 0267 | 0272 | 0277 |
| 58 | | | 0218 | 0223 | 0227 | 0232 | 0237 | 0242 | 0247 | 0252 | 0257 | 0261 | 0266 | 0271 | 0276 |
| 7 0 | | | 0217 | 0222 | 0226 | 0231 | 0236 | 0241 | 0246 | 0251 | 0255 | 0260 | 0265 | 0270 | 0275 |

Log. A, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | 44′ | 45′ | 46′ | 47′ | 48′ | 49′ | 50′ | 51′ | 52′ | 53′ | 54′ | 55′ | 56′ | 57′ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7° 0′ | .0222 | 0226 | 0231 | 0236 | 0241 | 0246 | 0251 | 0255 | 0260 | 0265 | 0270 | 0275 | | | |
| 3 | .0220 | 0225 | 0230 | 0234 | 0239 | 0244 | 0249 | 0254 | 0258 | 0263 | 0268 | 0273 | | | |
| 6 | .0218 | 0223 | 0228 | 0233 | 0238 | 0242 | 0247 | 0252 | 0257 | 0261 | 0266 | 0271 | | | |
| 9 | .0217 | 0222 | 0226 | 0231 | 0236 | 0241 | 0245 | 0250 | 0255 | 0260 | 0264 | 0269 | | | |
| 12 | .0215 | 0220 | 0225 | 0230 | 0234 | 0239 | 0244 | 0248 | 0253 | 0258 | 0262 | 0267 | | | |
| 7 15 | .0214 | 0219 | 0223 | 0228 | 0233 | 0237 | 0242 | 0247 | 0251 | 0256 | 0261 | 0265 | | | |
| 18 | .0213 | 0217 | 0222 | 0226 | 0231 | 0236 | 0240 | 0245 | 0250 | 0254 | 0259 | 0263 | | | |
| 21 | .0211 | 0216 | 0220 | 0225 | 0230 | 0234 | 0239 | 0243 | 0248 | 0253 | 0257 | 0262 | | | |
| 24 | .0210 | 0214 | 0219 | 0223 | 0228 | 0233 | 0237 | 0242 | 0246 | 0251 | 0255 | 0260 | | | |
| 27 | .0208 | 0213 | 0217 | 0222 | 0227 | 0231 | 0236 | 0240 | 0245 | 0249 | 0254 | 0258 | | | |
| 7 30 | .0207 | 0211 | 0216 | 0220 | 0225 | 0230 | 0234 | 0239 | 0243 | 0248 | 0252 | 0257 | | | |
| 33 | .0206 | 0210 | 0215 | 0219 | 0224 | 0228 | 0232 | 0237 | 0241 | 0246 | 0250 | 0255 | | | |
| 36 | .0204 | 0209 | 0213 | 0218 | 0222 | 0227 | 0231 | 0235 | 0240 | 0244 | 0249 | 0253 | | | |
| 39 | .0203 | 0207 | 0212 | 0216 | 0221 | 0225 | 0229 | 0234 | 0238 | 0243 | 0247 | 0252 | | | |
| 42 | .0202 | 0206 | 0210 | 0215 | 0219 | 0224 | 0228 | 0232 | 0237 | 0241 | 0246 | 0250 | | | |
| 7 45 | .0200 | 0205 | 0209 | 0213 | 0218 | 0222 | 0227 | 0231 | 0235 | 0240 | 0244 | 0248 | | | |
| 48 | .0199 | 0203 | 0208 | 0212 | 0216 | 0221 | 0225 | 0229 | 0234 | 0238 | 0242 | 0247 | | | |
| 51 | .0198 | 0202 | 0206 | 0211 | 0215 | 0219 | 0224 | 0228 | 0232 | 0237 | 0241 | 0245 | 0249 | | |
| 54 | .0196 | 0201 | 0205 | 0209 | 0214 | 0218 | 0222 | 0227 | 0231 | 0235 | 0239 | 0244 | 0248 | | |
| 57 | .0195 | 0200 | 0204 | 0208 | 0212 | 0217 | 0221 | 0225 | 0229 | 0234 | 0238 | 0242 | 0246 | | |
| 8 0 | .0194 | 0198 | 0203 | 0207 | 0211 | 0215 | 0219 | 0224 | 0228 | 0232 | 0236 | 0241 | 0245 | | |
| 3 | .0193 | 0197 | 0201 | 0206 | 0210 | 0214 | 0218 | 0222 | 0227 | 0231 | 0235 | 0239 | 0243 | | |
| 6 | .0192 | 0196 | 0200 | 0204 | 0208 | 0213 | 0217 | 0221 | 0225 | 0229 | 0233 | 0238 | 0242 | | |
| 9 | | 0195 | 0199 | 0203 | 0207 | 0211 | 0215 | 0220 | 0224 | 0228 | 0232 | 0236 | 0240 | | |
| 12 | | 0193 | 0198 | 0202 | 0206 | 0210 | 0214 | 0218 | 0222 | 0227 | 0231 | 0235 | 0239 | | |
| 8 15 | | 0192 | 0196 | 0201 | 0205 | 0209 | 0213 | 0217 | 0221 | 0225 | 0229 | 0233 | 0237 | | |
| 18 | | 0191 | 0195 | 0199 | 0203 | 0207 | 0212 | 0217 | 0220 | 0224 | 0228 | 0232 | 0236 | | |
| 21 | | 0190 | 0194 | 0198 | 0202 | 0206 | 0210 | 0214 | 0218 | 0222 | 0226 | 0231 | 0235 | | |
| 24 | | 0189 | 0193 | 0197 | 0201 | 0205 | 0209 | 0213 | 0217 | 0221 | 0225 | 0229 | 0233 | | |
| 27 | | 0188 | 0192 | 0196 | 0200 | 0204 | 0208 | 0212 | 0216 | 0220 | 0224 | 0228 | 0232 | | |
| 8 30 | | 0187 | 0191 | 0195 | 0199 | 0203 | 0207 | 0211 | 0215 | 0219 | 0223 | 0226 | 0230 | | |
| 33 | | 0186 | 0190 | 0193 | 0197 | 0201 | 0205 | 0209 | 0213 | 0217 | 0221 | 0225 | 0229 | | |
| 36 | | 0184 | 0188 | 0192 | 0196 | 0200 | 0204 | 0208 | 0212 | 0216 | 0220 | 0224 | 0228 | | |
| 39 | | 0183 | 0187 | 0191 | 0195 | 0199 | 0203 | 0207 | 0211 | 0215 | 0219 | 0223 | 0226 | | |
| 42 | | 0182 | 0186 | 0190 | 0194 | 0198 | 0202 | 0206 | 0210 | 0214 | 0217 | 0221 | 0225 | | |
| 8 45 | | 0181 | 0185 | 0189 | 0193 | 0197 | 0201 | 0205 | 0208 | 0212 | 0216 | 0220 | 0224 | | |
| 48 | | 0180 | 0184 | 0188 | 0192 | 0196 | 0200 | 0203 | 0207 | 0211 | 0215 | 0219 | 0223 | | |
| 51 | | 0179 | 0183 | 0187 | 0191 | 0195 | 0198 | 0202 | 0206 | 0210 | 0214 | 0218 | 0221 | | |
| 54 | | 0178 | 0182 | 0186 | 0190 | 0193 | 0197 | 0201 | 0205 | 0209 | 0212 | 0216 | 0220 | | |
| 57 | | 0177 | 0181 | 0185 | 0189 | 0192 | 0196 | 0200 | 0204 | 0208 | 0211 | 0215 | 0219 | | |
| 9 0 | | 0176 | 0180 | 0184 | 0188 | 0191 | 0195 | 0199 | 0203 | 0206 | 0210 | 0214 | 0218 | | |
| 3 | | 0175 | 0179 | 0183 | 0186 | 0190 | 0194 | 0198 | 0201 | 0205 | 0209 | 0213 | 0216 | | |
| 6 | | 0174 | 0178 | 0182 | 0185 | 0189 | 0193 | 0197 | 0200 | 0204 | 0208 | 0211 | 0215 | | |
| 9 | | 0173 | 0177 | 0181 | 0184 | 0188 | 0192 | 0196 | 0199 | 0203 | 0207 | 0210 | 0214 | | |
| 12 | | 0172 | 0176 | 0180 | 0183 | 0187 | 0191 | 0194 | 0198 | 0202 | 0206 | 0209 | 0213 | | |
| 9 15 | | 0171 | 0175 | 0179 | 0182 | 0186 | 0190 | 0193 | 0197 | 0201 | 0204 | 0208 | 0212 | | |
| 18 | | 0170 | 0174 | 0178 | 0181 | 0185 | 0189 | 0192 | 0196 | 0200 | 0203 | 0207 | 0211 | | |
| 21 | | 0170 | 0173 | 0177 | 0180 | 0184 | 0188 | 0191 | 0195 | 0199 | 0202 | 0206 | 0209 | | |
| 24 | | | 0172 | 0176 | 0179 | 0183 | 0187 | 0190 | 0194 | 0198 | 0201 | 0205 | 0208 | | |
| 27 | | | 0171 | 0175 | 0179 | 0182 | 0186 | 0189 | 0193 | 0196 | 0200 | 0204 | 0207 | | |
| 9 30 | | | 0170 | 0174 | 0178 | 0181 | 0185 | 0188 | 0192 | 0195 | 0199 | 0203 | 0206 | | |
| 33 | | | 0170 | 0173 | 0177 | 0180 | 0184 | 0187 | 0191 | 0194 | 0198 | 0201 | 0205 | | |
| 36 | | | 0169 | 0172 | 0176 | 0179 | 0183 | 0186 | 0190 | 0193 | 0197 | 0200 | 0204 | | |
| 39 | | | 0168 | 0171 | 0175 | 0178 | 0182 | 0185 | 0189 | 0192 | 0196 | 0199 | 0203 | | |
| 42 | | | 0167 | 0170 | 0174 | 0177 | 0181 | 0184 | 0188 | 0191 | 0195 | 0198 | 0202 | | |
| 9 45 | | | 0166 | 0169 | 0173 | 0176 | 0180 | 0183 | 0187 | 0190 | 0194 | 0197 | 0201 | | |
| 48 | | | 0165 | 0169 | 0172 | 0176 | 0179 | 0182 | 0186 | 0189 | 0193 | 0196 | 0200 | 0203 | |
| 51 | | | 0164 | 0168 | 0171 | 0175 | 0178 | 0182 | 0185 | 0188 | 0192 | 0195 | 0199 | 0202 | |
| 54 | | | 0163 | 0167 | 0170 | 0174 | 0177 | 0181 | 0184 | 0187 | 0191 | 0194 | 0198 | 0201 | |
| 57 | | | 0163 | 0166 | 0169 | 0173 | 0176 | 0180 | 0183 | 0186 | 0190 | 0193 | 0197 | 0200 | |
| 10 0 | | | 0162 | 0165 | 0169 | 0172 | 0175 | 0179 | 0182 | 0186 | 0189 | 0192 | 0196 | 0199 | |

# APPENDIX V: TABLE II.

Log. A, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | Reduced parallax and refraction of moon. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 46' | 47' | 48' | 49' | 50' | 51' | 52' | 53' | 54' | 55' | 56' | 57' | 58' | |
| 10° 0' | .0162 | 0165 | 0169 | 0172 | 0175 | 0179 | 0182 | 0186 | 0189 | 0192 | 0196 | 0199 | | |
| 5 | .0160 | 0164 | 0167 | 0171 | 0174 | 0177 | 0181 | 0184 | 0187 | 0191 | 0194 | 0197 | | |
| 10 | .0159 | 0162 | 0166 | 0169 | 0172 | 0176 | 0179 | 0182 | 0186 | 0189 | 0192 | 0196 | | |
| 15 | .0158 | 0161 | 0164 | 0168 | 0171 | 0174 | 0178 | 0181 | 0184 | 0187 | 0191 | 0194 | | |
| 20 | .0156 | 0160 | 0163 | 0166 | 0170 | 0173 | 0176 | 0179 | 0183 | 0186 | 0189 | 0192 | | |
| 25 | .0155 | 0158 | 0162 | 0165 | 0168 | 0171 | 0175 | 0178 | 0181 | 0184 | 0188 | 0191 | | |
| 10 30 | .0154 | 0157 | 0160 | 0164 | 0167 | 0170 | 0173 | 0177 | 0180 | 0183 | 0186 | 0189 | | |
| 35 | .0153 | 0156 | 0159 | 0162 | 0166 | 0169 | 0172 | 0175 | 0178 | 0181 | 0185 | 0188 | | |
| 40 | .0151 | 0155 | 0158 | 0161 | 0164 | 0167 | 0171 | 0174 | 0177 | 0180 | 0183 | 0186 | | |
| 45 | .0150 | 0153 | 0157 | 0160 | 0163 | 0166 | 0169 | 0172 | 0175 | 0179 | 0182 | 0185 | | |
| 50 | .0149 | 0152 | 0155 | 0158 | 0162 | 0165 | 0168 | 0171 | 0174 | 0177 | 0180 | 0183 | | |
| 55 | .0148 | 0151 | 0154 | 0157 | 0160 | 0163 | 0167 | 0170 | 0173 | 0176 | 0179 | 0182 | | |
| 11 0 | .0147 | 0150 | 0153 | 0156 | 0159 | 0162 | 0165 | 0168 | 0171 | 0174 | 0177 | 0181 | | |
| 5 | .0146 | 0149 | 0152 | 0155 | 0158 | 0161 | 0164 | 0167 | 0170 | 0173 | 0176 | 0179 | | |
| 10 | | 0148 | 0151 | 0154 | 0157 | 0160 | 0163 | 0166 | 0169 | 0172 | 0175 | 0178 | | |
| 15 | | 0146 | 0149 | 0152 | 0155 | 0158 | 0161 | 0164 | 0167 | 0170 | 0173 | 0176 | | |
| 20 | | 0145 | 0148 | 0151 | 0154 | 0157 | 0160 | 0163 | 0166 | 0169 | 0172 | 0175 | | |
| 25 | | 0144 | 0147 | 0150 | 0153 | 0156 | 0159 | 0162 | 0165 | 0168 | 0171 | 0174 | | |
| 11 30 | | 0143 | 0146 | 0149 | 0152 | 0155 | 0158 | 0161 | 0164 | 0167 | 0170 | 0172 | | |
| 35 | | 0142 | 0145 | 0148 | 0151 | 0154 | 0157 | 0160 | 0162 | 0165 | 0168 | 0171 | | |
| 40 | | 0141 | 0144 | 0147 | 0150 | 0153 | 0156 | 0158 | 0161 | 0164 | 0167 | 0170 | | |
| 45 | | 0140 | 0143 | 0146 | 0149 | 0151 | 0154 | 0157 | 0160 | 0163 | 0166 | 0169 | | |
| 50 | | 0139 | 0142 | 0145 | 0148 | 0150 | 0153 | 0156 | 0159 | 0162 | 0165 | 0167 | | |
| 55 | | 0138 | 0141 | 0144 | 0146 | 0149 | 0152 | 0155 | 0158 | 0161 | 0163 | 0166 | | |
| 12 0 | | 0137 | 0140 | 0143 | 0145 | 0148 | 0151 | 0154 | 0157 | 0159 | 0162 | 0165 | | |
| 5 | | 0136 | 0139 | 0142 | 0144 | 0147 | 0150 | 0153 | 0156 | 0158 | 0161 | 0164 | | |
| 10 | | 0135 | 0138 | 0141 | 0143 | 0146 | 0149 | 0152 | 0154 | 0157 | 0160 | 0163 | | |
| 15 | | 0134 | 0137 | 0140 | 0142 | 0145 | 0148 | 0151 | 0153 | 0156 | 0159 | 0162 | | |
| 20 | | 0133 | 0136 | 0139 | 0141 | 0144 | 0147 | 0150 | 0152 | 0155 | 0158 | 0160 | | |
| 25 | | 0132 | 0135 | 0138 | 0140 | 0143 | 0146 | 0148 | 0151 | 0154 | 0157 | 0159 | | |
| 12 30 | | 0131 | 0134 | 0137 | 0139 | 0142 | 0145 | 0147 | 0150 | 0153 | 0155 | 0158 | | |
| 35 | | 0130 | 0133 | 0136 | 0138 | 0141 | 0144 | 0146 | 0149 | 0152 | 0154 | 0157 | | |
| 40 | | 0129 | 0132 | 0135 | 0137 | 0140 | 0143 | 0145 | 0148 | 0151 | 0153 | 0156 | | |
| 45 | | 0129 | 0131 | 0134 | 0136 | 0139 | 0142 | 0144 | 0147 | 0150 | 0152 | 0155 | 0158 | |
| 50 | | 0128 | 0130 | 0133 | 0136 | 0138 | 0141 | 0143 | 0146 | 0149 | 0151 | 0154 | 0156 | |
| 55 | | 0127 | 0129 | 0132 | 0135 | 0137 | 0140 | 0142 | 0145 | 0148 | 0150 | 0153 | 0155 | |
| 13 0 | | 0126 | 0129 | 0131 | 0134 | 0136 | 0139 | 0141 | 0144 | 0147 | 0149 | 0152 | 0154 | |
| 5 | | 0125 | 0128 | 0130 | 0133 | 0135 | 0138 | 0141 | 0143 | 0146 | 0148 | 0151 | 0153 | |
| 10 | | 0124 | 0127 | 0129 | 0132 | 0135 | 0137 | 0140 | 0142 | 0145 | 0147 | 0150 | 0152 | |
| 15 | | 0123 | 0126 | 0129 | 0131 | 0134 | 0136 | 0139 | 0141 | 0144 | 0146 | 0149 | 0151 | |
| 20 | | 0123 | 0125 | 0128 | 0130 | 0133 | 0135 | 0138 | 0140 | 0143 | 0145 | 0148 | 0150 | |
| 25 | | 0122 | 0124 | 0127 | 0129 | 0132 | 0134 | 0137 | 0139 | 0142 | 0144 | 0147 | 0149 | |
| 13 30 | | 0121 | 0124 | 0126 | 0129 | 0131 | 0133 | 0136 | 0138 | 0141 | 0143 | 0146 | 0148 | |
| 35 | | 0120 | 0123 | 0125 | 0128 | 0130 | 0133 | 0135 | 0138 | 0140 | 0142 | 0145 | 0147 | |
| 40 | | 0120 | 0122 | 0124 | 0127 | 0129 | 0132 | 0134 | 0137 | 0139 | 0142 | 0144 | 0146 | |
| 45 | | | 0121 | 0124 | 0126 | 0128 | 0131 | 0133 | 0136 | 0138 | 0141 | 0143 | 0145 | |
| 50 | | | 0120 | 0123 | 0125 | 0128 | 0130 | 0132 | 0135 | 0137 | 0140 | 0142 | 0145 | |
| 55 | | | 0120 | 0122 | 0124 | 0127 | 0129 | 0132 | 0134 | 0136 | 0139 | 0141 | 0144 | |
| 14 0 | | | 0119 | 0121 | 0124 | 0126 | 0128 | 0131 | 0133 | 0136 | 0138 | 0140 | 0143 | |
| 5 | | | 0118 | 0121 | 0123 | 0125 | 0128 | 0130 | 0132 | 0135 | 0137 | 0139 | 0142 | |
| 10 | | | 0117 | 0120 | 0122 | 0124 | 0127 | 0129 | 0132 | 0134 | 0136 | 0139 | 0141 | |
| 15 | | | 0117 | 0119 | 0121 | 0124 | 0126 | 0128 | 0131 | 0133 | 0135 | 0138 | 0140 | |
| 20 | | | 0116 | 0118 | 0121 | 0123 | 0125 | 0128 | 0130 | 0132 | 0135 | 0137 | 0139 | |
| 25 | | | 0115 | 0118 | 0120 | 0122 | 0124 | 0127 | 0129 | 0131 | 0134 | 0136 | 0138 | |
| 14 30 | | | 0114 | 0117 | 0119 | 0121 | 0124 | 0126 | 0128 | 0131 | 0133 | 0135 | 0137 | |
| 35 | | | 0114 | 0116 | 0118 | 0121 | 0123 | 0125 | 0128 | 0130 | 0132 | 0134 | 0137 | |
| 40 | | | 0113 | 0115 | 0118 | 0120 | 0122 | 0124 | 0127 | 0129 | 0131 | 0134 | 0136 | |
| 45 | | | 0112 | 0115 | 0117 | 0119 | 0121 | 0124 | 0126 | 0128 | 0130 | 0133 | 0135 | |
| 50 | | | 0112 | 0114 | 0116 | 0118 | 0121 | 0123 | 0125 | 0127 | 0130 | 0132 | 0134 | |
| 55 | | | 0111 | 0113 | 0116 | 0118 | 0120 | 0122 | 0124 | 0127 | 0129 | 0131 | 0133 | |
| 15 0 | | | 0110 | 0113 | 0115 | 0117 | 0119 | 0121 | 0124 | 0126 | 0128 | 0130 | 0133 | |

### Log. A, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | 48' | 49' | 50' | 51' | 52' | 53' | 54' | 55' | 56' | 57' | 58' | 59' |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15° 0' | .0110 | 0113 | 0115 | 0117 | 0119 | 0121 | 0124 | 0126 | 0128 | 0130 | 0133 | |
| 10 | .0109 | 0111 | 0113 | 0116 | 0118 | 0120 | 0122 | 0124 | 0127 | 0129 | 0131 | |
| 20 | .0108 | 0110 | 0112 | 0114 | 0116 | 0119 | 0121 | 0123 | 0125 | 0127 | 0129 | |
| 30 | .0107 | 0109 | 0111 | 0113 | 0115 | 0117 | 0119 | 0121 | 0124 | 0126 | 0128 | |
| 40 | .0105 | 0107 | 0110 | 0112 | 0114 | 0116 | 0118 | 0120 | 0122 | 0124 | 0126 | |
| 50 | .0104 | 0106 | 0108 | 0110 | 0112 | 0115 | 0117 | 0119 | 0121 | 0123 | 0125 | |
| 16  0 | .0103 | 0105 | 0107 | 0109 | 0111 | 0113 | 0115 | 0117 | 0119 | 0121 | 0124 | |
| 10 | .0102 | 0104 | 0106 | 0108 | 0110 | 0112 | 0114 | 0116 | 0118 | 0120 | 0122 | |
| 20 | .0101 | 0103 | 0105 | 0107 | 0109 | 0111 | 0113 | 0115 | 0117 | 0119 | 0121 | |
| 30 | .0100 | 0102 | 0103 | 0105 | 0107 | 0109 | 0111 | 0113 | 0115 | 0117 | 0119 | |
| 40 | .0098 | 0100 | 0102 | 0104 | 0106 | 0108 | 0110 | 0112 | 0114 | 0116 | 0118 | |
| 50 | .0097 | 0099 | 0101 | 0103 | 0105 | 0107 | 0109 | 0111 | 0113 | 0115 | 0117 | |
| 17  0 | .0096 | 0098 | 0100 | 0102 | 0104 | 0106 | 0108 | 0110 | 0112 | 0114 | 0116 | |
| 10 | .0095 | 0097 | 0099 | 0101 | 0103 | 0105 | 0107 | 0109 | 0110 | 0112 | 0114 | |
| 20 | .0094 | 0096 | 0098 | 0100 | 0102 | 0104 | 0106 | 0107 | 0109 | 0111 | 0113 | |
| 30 | | 0095 | 0097 | 0099 | 0101 | 0103 | 0104 | 0106 | 0108 | 0110 | 0112 | |
| 40 | | 0094 | 0096 | 0098 | 0100 | 0101 | 0103 | 0105 | 0107 | 0109 | 0111 | |
| 50 | | 0093 | 0095 | 0097 | 0099 | 0100 | 0102 | 0104 | 0106 | 0108 | 0109 | |
| 18  0 | | 0092 | 0094 | 0096 | 0098 | 0099 | 0101 | 0103 | 0105 | 0107 | 0108 | |
| 10 | | 0091 | 0093 | 0095 | 0097 | 0098 | 0100 | 0102 | 0104 | 0105 | 0107 | 0109 |
| 20 | | 0090 | 0092 | 0094 | 0096 | 0097 | 0099 | 0101 | 0103 | 0104 | 0106 | 0108 |
| 30 | | 0089 | 0091 | 0093 | 0095 | 0096 | 0098 | 0100 | 0102 | 0103 | 0105 | 0107 |
| 40 | | 0088 | 0090 | 0092 | 0094 | 0095 | 0097 | 0099 | 0101 | 0102 | 0104 | 0106 |
| 50 | | 0088 | 0089 | 0091 | 0093 | 0094 | 0096 | 0098 | 0099 | 0101 | 0103 | 0105 |
| 19  0 | | 0087 | 0088 | 0090 | 0092 | 0093 | 0095 | 0097 | 0098 | 0100 | 0102 | 0104 |
| 10 | | 0086 | 0087 | 0089 | 0091 | 0092 | 0094 | 0096 | 0098 | 0099 | 0101 | 0103 |
| 20 | | 0085 | 0087 | 0088 | 0090 | 0092 | 0093 | 0095 | 0097 | 0098 | 0100 | 0102 |
| 30 | | 0084 | 0086 | 0087 | 0089 | 0091 | 0092 | 0094 | 0096 | 0097 | 0099 | 0101 |
| 40 | | 0083 | 0085 | 0087 | 0088 | 0090 | 0091 | 0093 | 0095 | 0096 | 0098 | 0100 |
| 50 | | 0082 | 0084 | 0086 | 0087 | 0089 | 0090 | 0092 | 0094 | 0095 | 0097 | 0099 |
| 20  0 | | 0082 | 0083 | 0085 | 0086 | 0088 | 0090 | 0091 | 0093 | 0094 | 0096 | 0098 |
| 10 | | 0081 | 0082 | 0084 | 0086 | 0087 | 0089 | 0090 | 0092 | 0093 | 0095 | 0097 |
| 20 | | 0080 | 0082 | 0083 | 0085 | 0086 | 0088 | 0089 | 0091 | 0093 | 0094 | 0096 |
| 30 | | 0079 | 0081 | 0082 | 0084 | 0086 | 0087 | 0089 | 0090 | 0092 | 0093 | 0095 |
| 40 | | 0079 | 0080 | 0082 | 0083 | 0085 | 0086 | 0088 | 0089 | 0091 | 0092 | 0094 |
| 50 | | 0078 | 0079 | 0081 | 0082 | 0084 | 0085 | 0087 | 0088 | 0090 | 0091 | 0093 |
| 21  0 | | 0077 | 0079 | 0080 | 0082 | 0083 | 0085 | 0086 | 0088 | 0089 | 0091 | 0092 |
| 10 | | 0076 | 0078 | 0079 | 0081 | 0082 | 0084 | 0085 | 0087 | 0088 | 0090 | 0091 |
| 20 | | 0076 | 0077 | 0079 | 0080 | 0082 | 0083 | 0085 | 0086 | 0087 | 0089 | 0090 |
| 30 | | 0075 | 0076 | 0078 | 0079 | 0081 | 0082 | 0084 | 0085 | 0087 | 0088 | 0090 |
| 40 | | 0074 | 0076 | 0077 | 0079 | 0080 | 0082 | 0083 | 0084 | 0086 | 0087 | 0089 |
| 50 | | 0074 | 0075 | 0076 | 0078 | 0079 | 0081 | 0082 | 0084 | 0085 | 0086 | 0088 |
| 22  0 | | 0073 | 0074 | 0076 | 0077 | 0079 | 0080 | 0081 | 0083 | 0084 | 0086 | 0087 |
| 10 | | 0072 | 0074 | 0075 | 0076 | 0078 | 0079 | 0081 | 0082 | 0083 | 0085 | 0086 |
| 20 | | 0072 | 0073 | 0074 | 0076 | 0077 | 0079 | 0080 | 0081 | 0083 | 0084 | 0086 |
| 30 | | 0071 | 0072 | 0074 | 0075 | 0076 | 0078 | 0079 | 0081 | 0082 | 0083 | 0085 |
| 40 | | 0070 | 0072 | 0073 | 0074 | 0076 | 0077 | 0079 | 0080 | 0081 | 0083 | 0084 |
| 50 | | 0070 | 0071 | 0072 | 0074 | 0075 | 0076 | 0078 | 0079 | 0081 | 0082 | 0083 |
| 23  0 | | 0069 | 0070 | 0072 | 0073 | 0074 | 0076 | 0077 | 0078 | 0080 | 0081 | 0082 |
| 10 | | 0068 | 0070 | 0071 | 0072 | 0074 | 0075 | 0076 | 0078 | 0079 | 0080 | 0082 |
| 20 | | 0068 | 0069 | 0070 | 0072 | 0073 | 0074 | 0076 | 0077 | 0078 | 0080 | 0081 |
| 30 | | 0067 | 0069 | 0070 | 0071 | 0072 | 0074 | 0075 | 0076 | 0078 | 0079 | 0080 |
| 40 | | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | 0074 | 0076 | 0077 | 0078 | 0080 |
| 50 | | 0066 | 0067 | 0069 | 0070 | 0071 | 0073 | 0074 | 0075 | 0076 | 0078 | 0079 |
| 24  0 | | | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | 0074 | 0076 | 0077 | 0078 |
| 10 | | | 0066 | 0067 | 0069 | 0070 | 0071 | 0073 | 0074 | 0075 | 0076 | 0078 |
| 20 | | | 0066 | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | 0074 | 0076 | 0077 |
| 30 | | | 0065 | 0066 | 0068 | 0069 | 0069 | 0071 | 0072 | 0073 | 0074 | 0076 |
| 40 | | | 0065 | 0066 | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | 0074 | 0076 |
| 50 | | | 0064 | 0065 | 0066 | 0068 | 0069 | 0070 | 0071 | 0072 | 0074 | 0075 |
| 25  0 | | | 0063 | 0065 | 0066 | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | 0074 |

# APPENDIX V: TABLE II.

Log. A, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | | Reduced parallax and refraction of moon. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50′ | 51′ | 52′ | 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | | | | |
| 25° 0′ | .0063 | 0065 | 0066 | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | 0074 | | | | | |
| 20 | .0062 | 0064 | 0065 | 0066 | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | | | | | |
| 40 | .0061 | 0062 | 0064 | 0065 | 0066 | 0067 | 0068 | 0069 | 0071 | 0072 | | | | | |
| 26 0 | .0060 | 0061 | 0063 | 0064 | 0065 | 0066 | 0067 | 0068 | 0069 | 0071 | | | | | |
| 20 | .0059 | 0060 | 0062 | 0063 | 0064 | 0065 | 0066 | 0067 | 0068 | 0069 | | | | | |
| 40 | .0058 | 0059 | 0061 | 0062 | 0063 | 0064 | 0065 | 0066 | 0067 | 0068 | | | | | |
| 27 0 | .0057 | 0058 | 0060 | 0061 | 0062 | 0063 | 0064 | 0065 | 0066 | 0067 | | | | | |
| 20 | .0056 | 0057 | 0059 | 0060 | 0061 | 0062 | 0063 | 0064 | 0065 | 0066 | | | | | |
| 40 | .0055 | 0057 | 0058 | 0059 | 0060 | 0061 | 0062 | 0063 | 0064 | 0065 | | | | | |
| 28 0 | .0055 | 0056 | 0057 | 0058 | 0059 | 0060 | 0061 | 0062 | 0063 | 0064 | | | | | |
| 20 | .0054 | 0055 | 0056 | 0057 | 0058 | 0059 | 0060 | 0061 | 0062 | 0063 | | | | | |
| 40 | .0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 | 0060 | 0061 | 0062 | | | | | |
| 29 0 | .0052 | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 | 0060 | 0061 | | | | | |
| 20 | .0051 | 0052 | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 | 0060 | | | | | |
| 40 | .0050 | 0051 | 0052 | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 | | | | | |
| 30 0 | .0050 | 0051 | 0051 | 0052 | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | | | | | |
| 20 | .0049 | 0050 | 0051 | 0052 | 0052 | 0053 | 0054 | 0055 | 0056 | 0057 | | | | | |
| 40 | .0048 | 0049 | 0050 | 0051 | 0052 | 0053 | 0053 | 0054 | 0055 | 0056 | | | | | |
| 31 0 | .0047 | 0048 | 0049 | 0050 | 0051 | 0052 | 0053 | 0053 | 0054 | 0055 | | | | | |
| 20 | .0047 | 0047 | 0048 | 0049 | 0050 | 0051 | 0052 | 0053 | 0054 | 0054 | 0055 | | | | |
| 40 | .0046 | 0047 | 0048 | 0048 | 0049 | 0050 | 0051 | 0052 | 0053 | 0054 | 0054 | | | | |
| 32 0 | .0045 | 0046 | 0047 | 0048 | 0048 | 0049 | 0050 | 0051 | 0052 | 0053 | 0054 | | | | |
| 20 | .0044 | 0045 | 0046 | 0047 | 0048 | 0049 | 0049 | 0050 | 0051 | 0052 | 0053 | | | | |
| 40 | .0044 | 0045 | 0045 | 0046 | 0047 | 0048 | 0049 | 0049 | 0050 | 0051 | 0052 | | | | |
| 33 0 | .0043 | 0044 | 0045 | 0045 | 0046 | 0047 | 0048 | 0049 | 0049 | 0050 | 0051 | | | | |
| 20 | .0042 | 0043 | 0044 | 0045 | 0046 | 0046 | 0047 | 0048 | 0049 | 0050 | 0050 | | | | |
| 40 | .0042 | 0043 | 0043 | 0044 | 0045 | 0045 | 0046 | 0047 | 0048 | 0049 | 0050 | | | | |
| 34 0 | .0041 | 0042 | 0043 | 0043 | 0044 | 0045 | 0046 | 0046 | 0047 | 0048 | 0049 | | | | |
| 20 | .0040 | 0041 | 0042 | 0043 | 0043 | 0044 | 0045 | 0046 | 0047 | 0047 | 0048 | | | | |
| 40 | .0040 | 0041 | 0041 | 0042 | 0043 | 0044 | 0044 | 0045 | 0046 | 0047 | 0047 | | | | |
| 35 0 | .0039 | 0040 | 0041 | 0041 | 0042 | 0043 | 0044 | 0044 | 0045 | 0046 | 0047 | | | | |
| 20 | .0039 | 0039 | 0040 | 0041 | 0042 | 0042 | 0043 | 0044 | 0044 | 0045 | 0046 | | | | |
| 40 | .0038 | 0039 | 0039 | 0040 | 0041 | 0042 | 0042 | 0043 | 0044 | 0044 | 0045 | | | | |
| 36 0 | .0037 | 0038 | 0039 | 0040 | 0040 | 0041 | 0042 | 0042 | 0043 | 0044 | 0044 | | | | |
| 20 | .0037 | 0038 | 0038 | 0039 | 0040 | 0040 | 0041 | 0042 | 0042 | 0043 | 0044 | | | | |
| 40 | .0036 | 0037 | 0038 | 0038 | 0039 | 0040 | 0040 | 0041 | 0042 | 0042 | 0043 | | | | |
| 37 0 | .0036 | 0036 | 0037 | 0038 | 0038 | 0039 | 0040 | 0040 | 0041 | 0042 | 0042 | | | | |
| 20 | .0035 | 0036 | 0037 | 0037 | 0038 | 0039 | 0039 | 0040 | 0040 | 0041 | 0042 | | | | |
| 40 | .0035 | 0035 | 0036 | 0037 | 0037 | 0038 | 0039 | 0039 | 0040 | 0040 | 0041 | | | | |
| 38 0 | .0034 | 0035 | 0035 | 0036 | 0037 | 0037 | 0038 | 0039 | 0039 | 0040 | 0040 | | | | |
| 20 | .0034 | 0034 | 0035 | 0036 | 0036 | 0037 | 0037 | 0038 | 0039 | 0039 | 0040 | | | | |
| 40 | .0033 | 0034 | 0034 | 0035 | 0036 | 0036 | 0037 | 0037 | 0038 | 0039 | 0039 | | | | |
| 39 0 | | 0033 | 0034 | 0034 | 0035 | 0036 | 0036 | 0037 | 0037 | 0038 | 0039 | | | | |
| 20 | | 0033 | 0033 | 0034 | 0035 | 0035 | 0036 | 0036 | 0037 | 0037 | 0038 | | | | |
| 40 | | 0032 | 0033 | 0033 | 0034 | 0035 | 0035 | 0036 | 0036 | 0037 | 0037 | | | | |
| 40 0 | | 0032 | 0032 | 0033 | 0033 | 0034 | 0035 | 0035 | 0036 | 0036 | 0037 | | | | |
| 20 | | 0031 | 0032 | 0032 | 0033 | 0034 | 0034 | 0035 | 0035 | 0036 | 0036 | | | | |
| 40 | | 0031 | 0031 | 0032 | 0032 | 0033 | 0034 | 0034 | 0035 | 0035 | 0036 | | | | |
| 41 0 | | 0030 | 0031 | 0031 | 0032 | 0033 | 0033 | 0034 | 0034 | 0035 | 0035 | | | | |
| 20 | | 0030 | 0030 | 0031 | 0031 | 0032 | 0033 | 0033 | 0034 | 0034 | 0035 | | | | |
| 40 | | 0029 | 0030 | 0030 | 0031 | 0032 | 0032 | 0033 | 0033 | 0034 | 0034 | | | | |
| 42 0 | | 0029 | 0029 | 0030 | 0031 | 0031 | 0032 | 0032 | 0033 | 0033 | 0034 | | | | |
| 20 | | 0029 | 0029 | 0030 | 0030 | 0031 | 0031 | 0032 | 0032 | 0033 | 0033 | | | | |
| 40 | | 0028 | 0029 | 0029 | 0030 | 0030 | 0031 | 0031 | 0032 | 0032 | 0033 | | | | |
| 43 0 | | 0028 | 0028 | 0029 | 0029 | 0030 | 0030 | 0031 | 0031 | 0032 | 0032 | | | | |
| 20 | | 0027 | 0028 | 0028 | 0029 | 0029 | 0030 | 0030 | 0031 | 0031 | 0032 | | | | |
| 40 | | 0027 | 0027 | 0028 | 0028 | 0029 | 0029 | 0030 | 0030 | 0031 | 0031 | | | | |
| 44 0 | | 0026 | 0027 | 0027 | 0028 | 0028 | 0029 | 0029 | 0030 | 0030 | 0031 | | | | |
| 20 | | 0026 | 0026 | 0027 | 0027 | 0028 | 0028 | 0029 | 0029 | 0030 | 0030 | | | | |
| 40 | | 0026 | 0026 | 0026 | 0027 | 0027 | 0028 | 0028 | 0029 | 0029 | 0030 | | | | |
| 45 0 | | 0025 | 0026 | 0026 | 0027 | 0027 | 0027 | 0028 | 0028 | 0029 | 0029 | | | | |

Log. A, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | Reduced parallax and refraction of moon. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 51′ | 52′ | 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ |
| 45° 0′ | .0025 | 0026 | 0026 | 0027 | 0027 | 0027 | 0028 | 0028 | 0029 | 0029 |
| 30 | .0025 | 0025 | 0025 | 0026 | 0026 | 0027 | 0027 | 0028 | 0028 | 0028 |
| 46 0 | .0024 | 0024 | 0025 | 0025 | 0026 | 0026 | 0027 | 0027 | 0027 | 0028 |
| 30 | .0023 | 0024 | 0024 | 0025 | 0025 | 0026 | 0026 | 0026 | 0027 | 0027 |
| 47 0 | .0023 | 0023 | 0024 | 0024 | 0025 | 0025 | 0025 | 0026 | 0026 | 0026 |
| 30 | .0022 | 0023 | 0023 | 0024 | 0024 | 0024 | 0025 | 0025 | 0025 | 0026 |
| 48 0 | .0022 | 0022 | 0023 | 0023 | 0023 | 0024 | 0024 | 0024 | 0025 | 0025 |
| 30 | .0021 | 0022 | 0022 | 0022 | 0023 | 0023 | 0024 | 0024 | 0024 | 0025 |
| 49 0 | .0021 | 0021 | 0022 | .0022 | 0022 | 0023 | 0023 | 0023 | 0024 | 0024 |
| 30 | .0020 | 0021 | 0021 | 0021 | 0022 | 0022 | 0022 | 0023 | 0023 | 0023 |
| 50 0 | .0020 | 0020 | 0020 | 0021 | 0021 | 0022 | 0022 | 0022 | 0023 | 0023 |
| 30 | .0019 | 0020 | 0020 | 0020 | 0021 | 0021 | 0021 | 0022 | 0022 | 0022 |
| 51 0 | .0019 | 0019 | 0020 | 0020 | 0020 | 0020 | 0021 | 0021 | 0021 | 0022 |
| 30 | .0018 | 0019 | 0019 | 0019 | 0020 | 0020 | 0020 | 0021 | 0021 | 0021 |
| 52 0 | .0018 | 0018 | 0019 | 0019 | 0019 | 0019 | 0020 | 0020 | 0020 | 0021 |
| 30 | .0018 | 0018 | 0018 | 0018 | 0019 | 0019 | 0019 | 0020 | 0020 | 0020 |
| 53 0 | .0017 | 0017 | 0018 | 0018 | 0018 | 0018 | 0019 | 0019 | 0019 | 0020 |
| 30 | .0017 | 0017 | 0017 | 0017 | 0018 | 0018 | 0018 | 0019 | 0019 | 0019 |
| 54 0 | .0016 | 0016 | 0017 | 0017 | 0017 | 0018 | 0018 | 0018 | 0018 | 0019 |
| 30 | .0016 | 0016 | 0016 | 0017 | 0017 | 0017 | 0017 | 0018 | 0018 | 0018 |
| 55 0 | .0015 | 0016 | 0016 | 0016 | 0016 | 0017 | 0017 | 0017 | 0017 | 0018 |
| 30 | .0015 | 0015 | 0015 | 0016 | 0016 | 0016 | 0016 | 0017 | 0017 | 0017 |
| 56 0 | .0015 | 0015 | 0015 | 0015 | 0016 | 0016 | 0016 | 0016 | 0017 | 0017 |
| 30 | .0014 | 0014 | 0015 | 0015 | 0015 | 0015 | 0016 | 0016 | 0016 | 0016 |
| 57 0 | .0014 | 0014 | 0014 | 0015 | 0015 | 0015 | 0015 | 0015 | 0016 | 0016 |
| 30 | .0014 | 0014 | 0014 | 0014 | 0014 | 0015 | 0015 | 0015 | 0015 | 0015 |
| 58 0 | .0013 | 0013 | 0014 | 0014 | 0014 | 0014 | 0014 | 0015 | 0015 | 0015 |
| 30 | .0013 | 0013 | 0013 | 0013 | 0014 | 0014 | 0014 | 0014 | 0014 | 0015 |
| 59 0 | .0012 | 0013 | 0013 | 0013 | 0013 | 0013 | 0014 | 0014 | 0014 | 0014 |
| 30 | .0012 | 0012 | 0012 | 0013 | 0013 | 0013 | 0013 | 0013 | 0014 | 0014 |
| 60 | .0012 | 0012 | 0012 | 0012 | 0013 | 0013 | 0013 | 0013 | 0013 | 0013 |
| 61 | .0011 | 0011 | 0011 | 0012 | 0012 | 0012 | 0012 | 0012 | 0012 | 0013 |
| 62 | .0011 | 0011 | 0011 | 0011 | 0011 | 0011 | 0011 | 0012 | 0012 | 0012 |
| 63 | .0010 | 0010 | 0010 | 0010 | 0011 | 0011 | 0011 | 0011 | 0011 | 0011 |
| 64 | .0009 | 0010 | 0010 | 0010 | 0010 | 0010 | 0010 | 0010 | 0010 | 0011 |
| 65 | .0009 | 0009 | 0009 | 0009 | 0009 | 0009 | 0010 | 0010 | 0010 | 0010 |
| 66 | .0008 | 0008 | 0009 | 0009 | 0009 | 0009 | 0009 | 0009 | 0009 | 0009 |
| 67 | .0008 | 0008 | 0008 | 0008 | 0008 | 0008 | 0008 | 0009 | 0009 | 0009 |
| 68 | .0007 | 0007 | 0008 | 0008 | 0008 | 0008 | 0008 | 0008 | 0008 | 0008 |
| 69 | .0007 | 0007 | 0007 | 0007 | 0007 | 0007 | 0007 | 0008 | 0008 | 0008 |
| 70 | .0007 | 0007 | 0007 | 0007 | 0007 | 0007 | 0007 | 0007 | 0007 | 0007 |
| 71 | .0006 | 0006 | 0006 | 0006 | 0006 | 0006 | 0007 | 0007 | 0007 | 0007 |
| 72 | .0006 | 0006 | 0006 | 0006 | 0006 | 0006 | 0006 | 0006 | 0006 | 0006 |
| 73 | .0005 | 0005 | 0006 | 0006 | 0006 | 0006 | 0006 | 0006 | 0006 | 0006 |
| 74 | .0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0006 |
| 75 | .0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 |
| 76 | .0004 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 | 0005 |
| 77 | .0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 |
| 78 | .0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 |
| 79 | .0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 |
| 80 | .0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 | 0004 |
| 81 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 82 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 83 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 84 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 85 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 86 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 87 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 88 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 89 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |
| 90 | .0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 | 0003 |

# APPENDIX V: TABLE III.

Log. B, for computing the First Correction of the Lunar Distance.

| App. alt. of sun or star. | 0′ 0″ | 0′ 30″ | 1′ 0″ | 1′ 30″ | 2′ 0″ | 2′ 30″ | 3′ 0″ | 3′ 30″ | 4′ 0″ | 4′ 30″ | 5′ 0″ | 5′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Reduced refraction and parallax of sun or star. | | | | | |
| 5° 0′ | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 6  0 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | 9.9970 |
| 40 | | | | | | | | | | | | 9.9972 |
| 7  0 | | | | | | | | | | | 9.9976 | 9.9974 |
| 20 | | | | | | | | | | | 9.9977 | 9.9975 |
| 40 | | | | | | | | | | 9.9981 | 9.9978 | 9.9976 |
| 8  0 | | | | | | | | | | 9.9982 | 9.9979 | 9.9977 |
| 20 | | | | | | | | | | 9.9982 | 9.9980 | 9.9978 |
| 40 | | | | | | | | | | 9.9983 | 9.9981 | 9.9979 |
| 9  0 | | | | | | | | | 9.9986 | 9.9984 | 9.9982 | 9.9980 |
| 20 | | | | | | | | | 9.9986 | 9.9985 | 9.9983 | 9.9981 |
| 40 | | | | | | | | | 9.9987 | 9.9985 | 9.9983 | 9.9982 |
| 10 | | | | | | | | 9.9989 | 9.9988 | 9.9986 | 9.9984 | 9.9982 |
| 11 | | | | | | | 9.9992 | 9.9991 | 9.9989 | 9.9987 | 9.9986 | 9.9984 |
| 12 | | | | | | | 9.9993 | 9.9992 | 9.9990 | 9.9989 | 9.9987 | 9.9986 |
| 13 | | | | | | 9.9995 | 9.9994 | 9.9992 | 9.9991 | 9.9990 | 9.9989 | 9.9987 |
| 14 | | | | | | 9.9995 | 9.9994 | 9.9993 | 9.9992 | 9.9991 | 9.9990 | |
| 15 | | | | | 9.9997 | 9.9996 | 9.9995 | 9.9994 | 9.9993 | 9.9992 | 9.9991 | |
| 16 | | | | | 9.9997 | 9.9996 | 9.9995 | 9.9994 | 9.9993 | 9.9993 | | |
| 18 | | | | 9.9999 | 9.9998 | 9.9997 | 9.9996 | 9.9995 | 9.9995 | 9.9995 | | |
| 20 | | | 0.0000 | 9.9999 | 9.9998 | 9.9998 | 9.9997 | 9.9996 | 9.9996 | | | |
| 25 | | | 0.0000 | 0.0000 | 9.9999 | 9.9999 | 9.9998 | 9.9998 | | | | |
| 30 | | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 9.9999 | | | | | |
| 50 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | | | | | | |
| 90 | 0.0001 | 0.0002 | 0.0002 | 0.0002 | | | | | | | | |

| App. alt. of sun or star. | 6′ 0″ | 6′ 30″ | 7′ 0″ | 7′ 30″ | 8′ 0″ | 8′ 30″ | 9′ 0″ | 9′ 30″ | 10′ 0″ | 10′ 30″ | 11′ 0″ | 11′ 30″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Reduced refraction and parallax of sun or star. | | | | | | |
| 5° 0′ | | | 9.9951 | 9.9947 | 9.9944 | 9.9940 | 9.9937 | 9.9933 | 9.9929 | 9.9926 | 9.9922 | 9.9919 |
| 10 | | | 9.9953 | 9.9949 | 9.9946 | 9.9942 | 9.9939 | 9.9935 | 9.9932 | 9.9928 | 9.9925 | 9.9921 |
| 20 | | | 9.9954 | 9.9951 | 9.9948 | 9.9944 | 9.9941 | 9.9937 | 9.9934 | 9.9931 | 9.9927 | 9.9924 |
| 30 | | 9.9959 | 9.9956 | 9.9952 | 9.9949 | 9.9946 | 9.9943 | 9.9939 | 9.9936 | 9.9933 | 9.9929 | |
| 40 | | 9.9960 | 9.9957 | 9.9954 | 9.9951 | 9.9948 | 9.9944 | 9.9941 | 9.9938 | 9.9935 | 9.9932 | |
| 50 | 9.9965 | 9.9962 | 9.9958 | 9.9955 | 9.9952 | 9.9949 | 9.9946 | 9.9943 | 9.9940 | 9.9937 | | |
| 6  0 | 9.9966 | 9.9963 | 9.9960 | 9.9957 | 9.9954 | 9.9951 | 9.9948 | 9.9945 | 9.9942 | 9.9939 | | |
| 20 | 9.9968 | 9.9965 | 9.9962 | 9.9959 | 9.9956 | 9.9954 | 9.9951 | 9.9948 | 9.9945 | | | |
| 40 | 9.9969 | 9.9967 | 9.9964 | 9.9961 | 9.9959 | 9.9956 | 9.9953 | 9.9951 | 9.9948 | | | |
| 7  0 | 9.9971 | 9.9968 | 9.9966 | 9.9963 | 9.9961 | 9.9958 | 9.9956 | 9.9953 | | | | |
| 20 | 9.9972 | 9.9970 | 9.9968 | 9.9965 | 9.9963 | 9.9960 | 9.9958 | | | | | |
| 40 | 9.9974 | 9.9971 | 9.9969 | 9.9967 | 9.9965 | 9.9962 | | | | | | |
| 8  0 | 9.9975 | 9.9973 | 9.9971 | 9.9968 | 9.9966 | 9.9964 | | | | | | |
| 20 | 9.9976 | 9.9974 | 9.9972 | 9.9970 | 9.9968 | | | | | | | |
| 40 | 9.9977 | 9.9975 | 9.9973 | 9.9971 | | | | | | | | |
| 9  0 | 9.9978 | 9.9976 | 9.9974 | 9.9972 | | | | | | | | |
| 20 | 9.9979 | 9.9977 | 9.9975 | | | | | | | | | |
| 40 | 9.9980 | 9.9978 | 9.9976 | | | | | | | | | |
| 10 | 9.9981 | 9.9979 | 9.9977 | | | | | | | | | |
| 11 | 9.9983 | 9.9981 | | | | | | | | | | |
| 12 | 9.9985 | | | | | | | | | | | |
| 13 | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |

Log. C, for computing the First Correction of the Lunar Distance.

| App. alt. of sun or star. | Reduced refraction and parallax of sun or star. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0' 0" | 0' 30" | 1' 0" | 1' 30" | 2' 0" | 2' 30" | 3' 0" | 3' 30" | 4' 0" | 4' 30" | 5' 0" | 5' 30" |
| 5° 0' | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| 6  0 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | 9.9969 |
| 40 | | | | | | | | | | | | 9.9970 |
| 7 | | | | | | | | | | | 9.9974 | 9.9972 |
| 8 | | | | | | | | | | 9.9980 | 9.9978 | 9.9975 |
| 9 | | | | | | | | | 9.9984 | 9.9982 | 9.9980 | 9.9978 |
| 10 | | | | | | | | 9.9988 | 9.9986 | 9.9984 | 9.9982 | 9.9981 |
| 11 | | | | | | | 9.9990 | 9.9989 | 9.9987 | 9.9986 | 9.9984 | 9.9982 |
| 12 | | | | | | | 9.9991 | 9.9990 | 9.9988 | 9.9987 | 9.9985 | 9.9984 |
| 13 | | | | | | 9.9993 | 9.9992 | 9.9991 | 9.9989 | 9.9988 | 9.9987 | 9.9985 |
| 14 | | | | | | 9.9994 | 9.9993 | 9.9991 | 9.9990 | 9.9989 | 9.9988 | |
| 15 | | | | | 9.9995 | 9.9994 | 9.9993 | 9.9992 | 9.9991 | 9.9990 | 9.9989 | |
| 16 | | | | | 9.9996 | 9.9995 | 9.9994 | 9.9993 | 9.9992 | 9.9990 | | |
| 17 | | | | | 9.9996 | 9.9995 | 9.9994 | 9.9993 | 9.9992 | 9.9991 | | |
| 18 | | | | 9.9997 | 9.9996 | 9.9995 | 9.9994 | 9.9994 | 9.9993 | | | |
| 20 | | | 9.9998 | 9.9998 | 9.9997 | 9.9996 | 9.9995 | 9.9994 | 9.9993 | | | |
| 25 | | | 9.9999 | 9.9998 | 9.9998 | 9.9997 | 9.9996 | 9.9996 | | | | |
| 30 | | 0.0000 | 9.9999 | 9.9999 | 9.9998 | 9.9998 | 9.9997 | | | | | |
| 40 | | 0.0000 | 9.9999 | 9.9999 | 9.9999 | 9.9999 | | | | | | |
| 50 | 0.0000 | 0.0000 | 0.0000 | 9.9999 | 9.9999 | | | | | | | |
| 90 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | | | | | | | |

| App. alt. of sun or star. | Reduced refraction and parallax of sun or star. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6' 0" | 6' 30" | 7' 0" | 7' 30" | 8' 0" | 8' 30" | 9' 0" | 9' 30" | 10' 0" | 10' 30" | 11' 0" | 11' 30" |
| 5° 0' | | | 9.9949 | 9.9946 | 9.9942 | 9.9938 | 9.9935 | 9.9931 | 9.9927 | 9.9924 | 9.9920 | 9.9916 |
| 20 | | 9.9956 | 9.9953 | 9.9949 | 9.9946 | 9.9942 | 9.9939 | 9.9936 | 9.9932 | 9.9929 | 9.9925 | 9.9922 |
| 40 | 9.9962 | 9.9959 | 9.9955 | 9.9952 | 9.9949 | 9.9946 | 9.9943 | 9.9939 | 9.9936 | 9.9933 | 9.9930 | |
| 6  0 | 9.9964 | 9.9961 | 9.9958 | 9.9955 | 9.9952 | 9.9949 | 9.9946 | 9.9943 | 9.9940 | 9.9937 | | |
| 20 | 9.9966 | 9.9963 | 9.9960 | 9.9957 | 9.9955 | 9.9952 | 9.9949 | 9.9946 | 9.9943 | | | |
| 40 | 9.9968 | 9.9965 | 9.9962 | 9.9960 | 9.9957 | 9.9954 | 9.9951 | 9.9949 | 9.9946 | | | |
| 7 | 9.9969 | 9.9967 | 9.9964 | 9.9962 | 9.9959 | 9.9956 | 9.9954 | 9.9951 | | | | |
| 8 | 9.9973 | 9.9971 | 9.9969 | 9.9966 | 9.9964 | 9.9962 | 9.9960 | | | | | |
| 9 | 9.9976 | 9.9974 | 9.9972 | 9.9970 | 9.9968 | | | | | | | |
| 10 | 9.9979 | 9.9977 | 9.9975 | | | | | | | | | |
| 11 | 9.9981 | 9.9979 | | | | | | | | | | |
| 12 | 9.9983 | | | | | | | | | | | |
| 13 | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |
| 90 | | | | | | | | | | | | |

# APPENDIX V: TABLE V.

Log. D, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | Reduced parallax and refraction of moon. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 41′ | 42′ | 43′ | 44′ | 45′ | 46′ | 47′ | 48′ | 49′ | 50′ | 51′ | 52′ | 53′ | 54′ | 55′ |
| 5° 0′ | .0283 | 0290 | 0296 | 0303 | 0310 | 0316 | 0323 | 0329 | 0336 | 0343 | 0349 | 0356 | 0362 | 0369 | |
| 3 | .0280 | 0287 | 0293 | 0300 | 0307 | 0313 | 0320 | 0326 | 0333 | 0339 | 0346 | 0352 | 0359 | 0365 | |
| 6 | .0277 | 0284 | 0291 | 0297 | 0304 | 0310 | 0317 | 0323 | 0330 | 0336 | 0342 | 0349 | 0355 | 0362 | |
| 9 | .0275 | 0281 | 0288 | 0294 | 0301 | 0307 | 0313 | 0320 | 0326 | 0333 | 0339 | 0345 | 0352 | 0358 | |
| 12 | .0272 | 0279 | 0285 | 0291 | 0298 | 0304 | 0310 | 0317 | 0323 | 0330 | 0336 | 0342 | 0349 | 0355 | |
| 5 15 | .0270 | 0276 | 0282 | 0289 | 0295 | 0301 | 0308 | 0314 | 0320 | 0326 | 0333 | 0339 | 0345 | 0351 | |
| 18 | .0267 | 0273 | 0280 | 0286 | 0292 | 0298 | 0305 | 0311 | 0317 | 0323 | 0330 | 0336 | 0342 | 0348 | |
| 21 | .0264 | 0271 | 0277 | 0283 | 0289 | 0296 | 0302 | 0308 | 0314 | 0320 | 0327 | 0333 | 0339 | 0345 | |
| 24 | .0262 | 0268 | 0274 | 0281 | 0287 | 0293 | 0299 | 0305 | 0311 | 0317 | 0324 | 0330 | 0336 | 0342 | |
| 27 | .0260 | 0266 | 0272 | 0278 | 0284 | 0290 | 0296 | 0302 | 0308 | 0314 | 0321 | 0327 | 0333 | 0339 | |
| 5 30 | .0257 | 0263 | 0269 | 0275 | 0282 | 0288 | 0294 | 0300 | 0306 | 0312 | 0318 | 0324 | 0330 | 0336 | |
| 33 | .0255 | 0261 | 0267 | 0273 | 0279 | 0285 | 0291 | 0297 | 0303 | 0309 | 0315 | 0321 | 0327 | 0333 | |
| 36 | .0253 | 0259 | 0265 | 0271 | 0276 | 0282 | 0288 | 0294 | 0300 | 0306 | 0312 | 0318 | 0324 | 0330 | |
| 39 | | 0256 | 0262 | 0268 | 0274 | 0280 | 0286 | 0292 | 0298 | 0303 | 0309 | 0315 | 0321 | 0327 | |
| 42 | | 0254 | 0260 | 0266 | 0272 | 0277 | 0283 | 0289 | 0295 | 0301 | 0306 | 0312 | 0318 | 0324 | |
| 5 45 | | 0252 | 0258 | 0263 | 0269 | 0275 | 0281 | 0287 | 0292 | 0298 | 0304 | 0310 | 0315 | 0321 | |
| 48 | | 0250 | 0255 | 0261 | 0267 | 0273 | 0278 | 0284 | 0290 | 0295 | 0301 | 0307 | 0313 | 0318 | |
| 51 | | 0247 | 0253 | 0259 | 0265 | 0270 | 0276 | 0282 | 0287 | 0293 | 0299 | 0304 | 0310 | 0316 | |
| 54 | | 0245 | 0251 | 0257 | 0262 | 0268 | 0274 | 0279 | 0285 | 0290 | 0296 | 0302 | 0307 | 0313 | |
| 57 | | 0243 | 0249 | 0254 | 0260 | 0266 | 0271 | 0277 | 0282 | 0288 | 0294 | 0299 | 0305 | 0310 | |
| 6 0 | | 0241 | 0247 | 0252 | 0258 | 0263 | 0269 | 0275 | 0280 | 0286 | 0291 | 0297 | 0302 | 0308 | |
| 3 | | 0239 | 0245 | 0250 | 0256 | 0261 | 0267 | 0272 | 0278 | 0283 | 0289 | 0294 | 0300 | 0305 | |
| 6 | | 0237 | 0243 | 0248 | 0254 | 0259 | 0265 | 0270 | 0275 | 0281 | 0286 | 0292 | 0297 | 0302 | |
| 9 | | 0235 | 0241 | 0246 | 0252 | 0257 | 0262 | 0268 | 0273 | 0279 | 0284 | 0289 | 0295 | 0300 | |
| 12 | | 0233 | 0239 | 0244 | 0249 | 0255 | 0260 | 0266 | 0271 | 0276 | 0282 | 0287 | 0292 | 0298 | |
| 6 15 | | 0231 | 0237 | 0242 | 0247 | 0253 | 0258 | 0263 | 0269 | 0274 | 0279 | 0285 | 0290 | 0295 | |
| 18 | | 0230 | 0235 | 0240 | 0245 | 0251 | 0256 | 0261 | 0267 | 0272 | 0277 | 0282 | 0288 | 0293 | |
| 21 | | 0228 | 0233 | 0238 | 0243 | 0249 | 0254 | 0259 | 0264 | 0270 | 0275 | 0280 | 0285 | 0290 | |
| 24 | | 0226 | 0231 | 0236 | 0342 | 0247 | 0252 | 0257 | 0262 | 0267 | 0273 | 0278 | 0283 | 0288 | |
| 27 | | | 0229 | 0234 | 0240 | 0245 | 0250 | 0255 | 0260 | 0265 | 0271 | 0276 | 0281 | 0286 | 0291 |
| 6 30 | | | 0227 | 0233 | 0238 | 0243 | 0248 | 0253 | 0258 | 0263 | 0268 | 0274 | 0279 | 0284 | 0289 |
| 33 | | | 0226 | 0231 | 0236 | 0241 | 0246 | 0251 | 0256 | 0261 | 0266 | 0271 | 0276 | 0281 | 0287 |
| 36 | | | 0224 | 0229 | 0234 | 0239 | 0244 | 0249 | 0254 | 0259 | 0264 | 0269 | 0274 | 0279 | 0284 |
| 39 | | | 0222 | 0227 | 0232 | 0237 | 0242 | 0247 | 0252 | 0257 | 0262 | 0267 | 0272 | 0277 | 0282 |
| 42 | | | 0220 | 0225 | 0230 | 0235 | 0240 | 0245 | 0250 | 0255 | 0260 | 0265 | 0270 | 0275 | 0280 |
| 6 45 | | | 0219 | 0224 | 0229 | 0234 | 0239 | 0244 | 0248 | 0253 | 0258 | 0263 | 0268 | 0273 | 0278 |
| 48 | | | 0217 | 0222 | 0227 | 0232 | 0237 | 0242 | 0247 | 0251 | 0256 | 0261 | 0266 | 0271 | 0276 |
| 51 | | | 0216 | 0220 | 0225 | 0230 | 0235 | 0240 | 0245 | 0250 | 0254 | 0259 | 0264 | 0269 | 0274 |
| 54 | | | 0214 | 0219 | 0224 | 0228 | 0233 | 0238 | 0243 | 0248 | 0253 | 0257 | 0262 | 0267 | 0272 |
| 57 | | | 0212 | 0217 | 0222 | 0227 | 0232 | 0236 | 0241 | 0246 | 0251 | 0255 | 0260 | 0265 | 0270 |
| 7 0 | | | 0211 | 0216 | 0220 | 0225 | 0230 | 0235 | 0239 | 0244 | 0249 | 0254 | 0258 | 0263 | 0268 |
| 3 | | | 0209 | 0214 | 0219 | 0223 | 0228 | 0233 | 0238 | 0242 | 0247 | 0252 | 0256 | 0261 | 0266 |
| 6 | | | 0208 | 0212 | 0217 | 0222 | 0227 | 0231 | 0236 | 0241 | 0245 | 0250 | 0255 | 0259 | 0264 |
| 9 | | | | 0211 | 0216 | 0220 | 0225 | 0230 | 0234 | 0239 | 0243 | 0248 | 0253 | 0257 | 0262 |
| 12 | | | | 0209 | 0214 | 0219 | 0223 | 0228 | 0232 | 0237 | 0242 | 0246 | 0251 | 0255 | 0260 |
| 7 15 | | | | 0208 | 0212 | 0217 | 0222 | 0226 | 0231 | 0235 | 0240 | 0245 | 0249 | 0254 | 0258 |
| 18 | | | | 0206 | 0211 | 0216 | 0220 | 0225 | 0229 | 0234 | 0238 | 0243 | 0247 | 0252 | 0256 |
| 21 | | | | 0205 | 0209 | 0214 | 0219 | 0223 | 0228 | 0232 | 0237 | 0241 | 0246 | 0250 | 0255 |
| 24 | | | | 0204 | 0208 | 0213 | 0217 | 0222 | 0226 | 0230 | 0235 | 0239 | 0244 | 0248 | 0253 |
| 27 | | | | 0202 | 0207 | 0211 | 0216 | 0220 | 0224 | 0229 | 0233 | 0238 | 0242 | 0247 | 0251 |
| 7 30 | | | | 0201 | 0205 | 0210 | 0214 | 0218 | 0223 | 0227 | 0232 | 0236 | 0241 | 0245 | 0249 |
| 33 | | | | 0199 | 0204 | 0208 | 0213 | 0217 | 0221 | 0226 | 0230 | 0234 | 0239 | 0243 | 0248 |
| 36 | | | | 0198 | 0202 | 0207 | 0211 | 0215 | 0220 | 0224 | 0229 | 0233 | 0237 | 0242 | 0246 |
| 39 | | | | 0197 | 0201 | 0205 | 0210 | 0214 | 0218 | 0223 | 0227 | 0231 | 0236 | 0240 | 0244 |
| 42 | | | | 0195 | 0200 | 0204 | 0208 | 0213 | 0217 | 0221 | 0225 | 0230 | 0234 | 0238 | 0243 |
| 7 45 | | | | 0194 | 0198 | 0203 | 0207 | 0211 | 0215 | 0220 | 0224 | 0228 | 0232 | 0237 | 0241 |
| 48 | | | | 0193 | 0197 | 0201 | 0205 | 0210 | 0214 | 0218 | 0222 | 0227 | 0231 | 0235 | 0239 |
| 51 | | | | 0191 | 0196 | 0200 | 0204 | 0208 | 0213 | 0217 | 0221 | 0225 | 0229 | 0234 | 0238 |
| 54 | | | | 0190 | 0194 | 0198 | 0203 | 0207 | 0211 | 0215 | 0219 | 0224 | 0228 | 0232 | 0236 |
| 57 | | | | 0189 | 0193 | 0197 | 0201 | 0206 | 0210 | 0214 | 0218 | 0222 | 0226 | 0230 | 0235 |
| 8 0 | | | | 0188 | 0192 | 0196 | 0200 | 0204 | 0208 | 0212 | 0217 | 0221 | 0225 | 0229 | 0233 |

Log. D, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | 45' | 46' | 47' | 48' | 49' | 50' | 51' | 52' | 53' | 54' | 55' | 56' | 57' | 58' | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Reduced parallax and refraction of moon. | | | | | | | | | |
| 8° 0' | .0192 | 0196 | 0200 | 0204 | 0208 | 0212 | 0217 | 0221 | 0225 | 0229 | 0233 | 0237 | | | |
| 5 | .0190 | 0194 | 0198 | 0202 | 0206 | 0210 | 0214 | 0218 | 0222 | 0227 | 0231 | 0235 | | | |
| 10 | .0188 | 0192 | 0196 | 0200 | 0204 | 0208 | 0212 | 0216 | 0220 | 0224 | 0228 | 0232 | | | |
| 15 | .0186 | 0190 | 0194 | 0198 | 0202 | 0206 | 0210 | 0214 | 0218 | 0222 | 0226 | 0230 | | | |
| 20 | .0184 | 0188 | 0192 | 0196 | 0200 | 0204 | 0207 | 0211 | 0215 | 0219 | 0223 | 0227 | | | |
| 25 | .0182 | 0186 | 0190 | 0194 | 0197 | 0201 | 0205 | 0209 | 0213 | 0217 | 0221 | 0225 | | | |
| 8 30 | .0180 | 0184 | 0188 | 0192 | 0195 | 0199 | 0203 | 0207 | 0211 | 0215 | 0219 | 0223 | | | |
| 35 | .0178 | 0182 | 0186 | 0190 | 0193 | 0197 | 0201 | 0205 | 0209 | 0213 | 0216 | 0220 | | | |
| 40 | .0176 | 0180 | 0184 | 0188 | 0191 | 0195 | 0199 | 0203 | 0207 | 0210 | 0214 | 0218 | | | |
| 45 | .0174 | 0178 | 0182 | 0186 | 0189 | 0193 | 0197 | 0201 | 0205 | 0208 | 0212 | 0216 | | | |
| 50 | .0173 | 0176 | 0180 | 0184 | 0188 | 0191 | 0195 | 0199 | 0202 | 0206 | 0210 | 0214 | | | |
| 55 | .0171 | 0175 | 0178 | 0182 | 0186 | 0189 | 0193 | 0197 | 0200 | 0204 | 0208 | 0212 | | | |
| 9 0 | .0169 | 0173 | 0177 | 0180 | 0184 | 0188 | 0191 | 0195 | 0198 | 0202 | 0206 | 0209 | | | |
| 5 | .0167 | 0171 | 0175 | 0178 | 0182 | 0186 | 0189 | 0193 | 0197 | 0200 | 0204 | 0207 | | | |
| 10 | .0166 | 0169 | 0173 | 0177 | 0180 | 0184 | 0187 | 0191 | 0195 | 0198 | 0202 | 0205 | | | |
| 15 | .0164 | 0168 | 0171 | 0175 | 0179 | 0182 | 0186 | 0189 | 0193 | 0196 | 0200 | 0203 | | | |
| 20 | .0163 | 0166 | 0170 | 0173 | 0177 | 0180 | 0184 | 0187 | 0191 | 0194 | 0198 | 0201 | | | |
| 25 | .0161 | 0165 | 0168 | 0172 | 0175 | 0179 | 0182 | 0186 | 0189 | 0193 | 0196 | 0199 | | | |
| 9 30 | | 0163 | 0166 | 0170 | 0173 | 0177 | 0180 | 0184 | 0187 | 0191 | 0194 | 0198 | | | |
| 35 | | 0161 | 0165 | 0168 | 0172 | 0175 | 0179 | 0182 | 0185 | 0189 | 0192 | 0196 | | | |
| 40 | | 0160 | 0163 | 0167 | 0170 | 0174 | 0177 | 0180 | 0184 | 0187 | 0191 | 0194 | | | |
| 45 | | 0158 | 0162 | 0165 | 0169 | 0172 | 0175 | 0179 | 0182 | 0185 | 0189 | 0192 | 0195 | | |
| 50 | | 0157 | 0160 | 0164 | 0167 | 0170 | 0174 | 0177 | 0180 | 0184 | 0187 | 0190 | 0194 | | |
| 55 | | 0156 | 0159 | 0162 | 0165 | 0169 | 0172 | 0175 | 0179 | 0182 | 0185 | 0189 | 0192 | | |
| 10 0 | | 0154 | 0157 | 0161 | 0164 | 0167 | 0171 | 0174 | 0177 | 0180 | 0184 | 0187 | 0190 | | |
| 5 | | 0153 | 0156 | 0159 | 0162 | 0166 | 0169 | 0172 | 0175 | 0179 | 0182 | 0185 | 0188 | | |
| 10 | | 0151 | 0155 | 0158 | 0161 | 0164 | 0167 | 0171 | 0174 | 0177 | 0180 | 0183 | 0187 | | |
| 15 | | 0150 | 0153 | 0156 | 0160 | 0163 | 0166 | 0169 | 0172 | 0175 | 0179 | 0182 | 0185 | | |
| 20 | | 0149 | 0152 | 0155 | 0158 | 0161 | 0164 | 0168 | 0171 | 0174 | 0177 | 0180 | 0183 | | |
| 25 | | 0147 | 0150 | 0154 | 0157 | 0160 | 0163 | 0166 | 0169 | 0172 | 0175 | 0179 | 0182 | | |
| 10 30 | | 0146 | 0149 | 0152 | 0155 | 0158 | 0162 | 0165 | 0168 | 0171 | 0174 | 0177 | 0180 | | |
| 35 | | 0145 | 0148 | 0151 | 0154 | 0157 | 0160 | 0163 | 0166 | 0169 | 0172 | 0175 | 0179 | | |
| 40 | | 0143 | 0147 | 0150 | 0153 | 0156 | 0159 | 0162 | 0165 | 0168 | 0171 | 0174 | 0177 | | |
| 45 | | 0142 | 0145 | 0148 | 0151 | 0154 | 0157 | 0160 | 0163 | 0166 | 0169 | 0172 | 0175 | | |
| 50 | | 0141 | 0144 | 0147 | 0150 | 0153 | 0156 | 0159 | 0162 | 0165 | 0168 | 0171 | 0174 | | |
| 55 | | 0140 | 0143 | 0146 | 0149 | 0152 | 0155 | 0158 | 0161 | 0164 | 0167 | 0170 | 0172 | | |
| 11 0 | | 0139 | 0142 | 0145 | 0147 | 0150 | 0153 | 0156 | 0159 | 0162 | 0165 | 0168 | 0171 | | |
| 5 | | 0137 | 0140 | 0143 | 0146 | 0149 | 0152 | 0155 | 0158 | 0161 | 0164 | 0167 | 0170 | | |
| 10 | | | 0139 | 0142 | 0145 | 0148 | 0151 | 0154 | 0157 | 0159 | 0162 | 0165 | 0168 | | |
| 15 | | | 0138 | 0141 | 0144 | 0147 | 0150 | 0152 | 0155 | 0158 | 0161 | 0164 | 0167 | | |
| 20 | | | 0137 | 0140 | 0143 | 0145 | 0148 | 0151 | 0154 | 0157 | 0160 | 0163 | 0165 | | |
| 25 | | | 0136 | 0139 | 0141 | 0144 | 0147 | 0150 | 0153 | 0156 | 0158 | 0161 | 0164 | | |
| 11 30 | | | 0135 | 0137 | 0140 | 0143 | 0146 | 0149 | 0151 | 0154 | 0157 | 0160 | 0163 | | |
| 35 | | | 0133 | 0136 | 0139 | 0142 | 0145 | 0147 | 0150 | 0153 | 0156 | 0159 | 0161 | | |
| 40 | | | 0132 | 0135 | 0138 | 0141 | 0143 | 0146 | 0149 | 0152 | 0154 | 0157 | 0160 | | |
| 45 | | | 0131 | 0134 | 0137 | 0140 | 0142 | 0145 | 0148 | 0150 | 0153 | 0156 | 0159 | | |
| 50 | | | 0130 | 0133 | 0136 | 0138 | 0141 | 0144 | 0147 | 0149 | 0152 | 0155 | 0157 | | |
| 55 | | | 0129 | 0132 | 0135 | 0137 | 0140 | 0143 | 0145 | 0148 | 0151 | 0153 | 0156 | | |
| 12 0 | | | 0128 | 0131 | 0134 | 0136 | 0139 | 0142 | 0144 | 0147 | 0150 | 0152 | 0155 | | |
| 5 | | | 0127 | 0130 | 0132 | 0135 | 0138 | 0140 | 0143 | 0146 | 0148 | 0151 | 0154 | | |
| 10 | | | 0126 | 0129 | 0131 | 0134 | 0137 | 0139 | 0142 | 0145 | 0147 | 0150 | 0152 | | |
| 15 | | | 0125 | 0128 | 0130 | 0133 | 0136 | 0138 | 0141 | 0143 | 0146 | 0149 | 0151 | | |
| 20 | | | 0124 | 0127 | 0129 | 0132 | 0135 | 0137 | 0140 | 0142 | 0145 | 0147 | 0150 | | |
| 25 | | | 0123 | 0126 | 0128 | 0131 | 0133 | 0136 | 0139 | 0141 | 0144 | 0146 | 0149 | | |
| 12 30 | | | 0122 | 0125 | 0127 | 0130 | 0132 | 0135 | 0138 | 0140 | 0143 | 0145 | 0148 | | |
| 35 | | | 0121 | 0124 | 0126 | 0129 | 0131 | 0134 | 0136 | 0139 | 0141 | 0144 | 0147 | | |
| 40 | | | 0120 | 0123 | 0125 | 0128 | 0130 | 0133 | 0135 | 0138 | 0140 | 0143 | 0145 | | |
| 45 | | | 0119 | 0122 | 0124 | 0127 | 0129 | 0132 | 0134 | 0137 | 0139 | 0142 | 0144 | 0147 | |
| 50 | | | 0118 | 0121 | 0123 | 0126 | 0128 | 0131 | 0133 | 0136 | 0138 | 0141 | 0143 | 0146 | |
| 55 | | | 0118 | 0120 | 0123 | 0125 | 0127 | 0130 | 0132 | 0135 | 0137 | 0140 | 0142 | 0145 | |
| 13 0 | | | 0117 | 0119 | 0122 | 0124 | 0126 | 0129 | 0131 | 0134 | 0136 | 0139 | 0141 | 0143 | |

# APPENDIX V: TABLE V.

Log. D, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | Reduced parallax and refraction of moon. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 47′ | 48′ | 49′ | 50′ | 51′ | 52′ | 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ |
| 13° 0′ | .0117 | 0119 | 0122 | 0124 | 0126 | 0129 | 0131 | 0134 | 0136 | 0139 | 0141 | 0143 | |
| 10 | .0115 | 0117 | 0120 | 0122 | 0125 | 0127 | 0129 | 0132 | 0134 | 0137 | 0139 | 0141 | |
| 20 | .0113 | 0116 | 0118 | 0120 | 0123 | 0125 | 0127 | 0130 | 0132 | 0134 | 0137 | 0139 | |
| 30 | .0112 | 0114 | 0116 | 0119 | 0121 | 0123 | 0125 | 0128 | 0130 | 0132 | 0135 | 0137 | |
| 40 | | 0112 | 0114 | 0117 | 0119 | 0121 | 0124 | 0126 | 0128 | 0131 | 0133 | 0135 | |
| 50 | | 0111 | 0113 | 0115 | 0117 | 0120 | 0122 | 0124 | 0126 | 0129 | 0131 | 0133 | |
| 14 0 | | 0109 | 0111 | 0113 | 0116 | 0118 | 0120 | 0122 | 0125 | 0127 | 0129 | 0131 | |
| 10 | | 0107 | 0110 | 0112 | 0114 | 0116 | 0118 | 0121 | 0123 | 0125 | 0127 | 0129 | |
| 20 | | 0106 | 0108 | 0110 | 0112 | 0114 | 0117 | 0119 | 0121 | 0123 | 0125 | 0127 | |
| 30 | | 0104 | 0106 | 0109 | 0111 | 0113 | 0115 | 0117 | 0119 | 0121 | 0123 | 0126 | |
| 40 | | 0103 | 0105 | 0107 | 0109 | 0111 | 0113 | 0115 | 0118 | 0120 | 0122 | 0124 | |
| 50 | | 0101 | 0103 | 0106 | 0108 | 0110 | 0112 | 0114 | 0116 | 0118 | 0120 | 0122 | |
| 15 0 | | 0100 | 0102 | 0104 | 0106 | 0108 | 0110 | 0112 | 0114 | 0116 | 0118 | 0120 | |
| 10 | | 0099 | 0101 | 0103 | 0105 | 0107 | 0109 | 0111 | 0113 | 0115 | 0117 | 0119 | |
| 20 | | 0097 | 0099 | 0101 | 0103 | 0105 | 0107 | 0109 | 0111 | 0113 | 0115 | 0117 | |
| 30 | | 0096 | 0098 | 0100 | 0102 | 0104 | 0106 | 0108 | 0110 | 0112 | 0113 | 0115 | |
| 40 | | 0094 | 0096 | 0098 | 0100 | 0102 | 0104 | 0106 | 0108 | 0110 | 0112 | 0114 | |
| 50 | | 0093 | 0095 | 0097 | 0099 | 0101 | 0103 | 0105 | 0107 | 0108 | 0110 | 0112 | |
| 16 0 | | 0092 | 0094 | 0096 | 0098 | 0099 | 0101 | 0103 | 0105 | 0107 | 0109 | 0111 | |
| 10 | | 0091 | 0093 | 0094 | 0096 | 0098 | 0100 | 0102 | 0104 | 0106 | 0107 | 0109 | |
| 20 | | 0089 | 0091 | 0093 | 0095 | 0097 | 0099 | 0100 | 0102 | 0104 | 0106 | 0108 | |
| 30 | | 0088 | 0090 | 0092 | 0094 | 0096 | 0097 | 0099 | 0101 | 0103 | 0105 | 0106 | |
| 40 | | 0087 | 0089 | 0091 | 0092 | 0094 | 0096 | 0098 | 0100 | 0101 | 0103 | 0105 | |
| 50 | | 0086 | 0088 | 0089 | 0091 | 0093 | 0095 | 0096 | 0098 | 0100 | 0102 | 0104 | |
| 17 0 | | 0085 | 0087 | 0088 | 0090 | 0092 | 0093 | 0095 | 0097 | 0099 | 0100 | 0102 | |
| 10 | | 0084 | 0085 | 0087 | 0089 | 0091 | 0092 | 0094 | 0096 | 0097 | 0099 | 0101 | |
| 20 | | 0083 | 0084 | 0086 | 0088 | 0089 | 0091 | 0093 | 0094 | 0096 | 0098 | 0099 | |
| 30 | | | 0083 | 0085 | 0086 | 0088 | 0090 | 0091 | 0093 | 0095 | 0096 | 0098 | |
| 40 | | | 0082 | 0084 | 0085 | 0087 | 0089 | 0090 | 0092 | 0094 | 0095 | 0097 | |
| 50 | | | 0081 | 0083 | 0084 | 0086 | 0087 | 0089 | 0091 | 0092 | 0094 | 0096 | |
| 18 0 | | | 0080 | 0082 | 0083 | 0085 | 0086 | 0088 | 0090 | 0091 | 0093 | 0094 | |
| 20 | | | 0078 | 0079 | 0081 | 0083 | 0084 | 0086 | 0087 | 0089 | 0090 | 0092 | 0093 |
| 40 | | | 0076 | 0077 | 0079 | 0080 | 0082 | 0083 | 0085 | 0087 | 0088 | 0090 | 0091 |
| 19 0 | | | 0074 | 0075 | 0077 | 0078 | 0080 | 0081 | 0083 | 0084 | 0086 | 0087 | 0089 |
| 20 | | | 0072 | 0073 | 0075 | 0076 | 0078 | 0079 | 0081 | 0082 | 0084 | 0085 | 0086 |
| 40 | | | 0070 | 0072 | 0073 | 0074 | 0076 | 0077 | 0079 | 0080 | 0081 | 0083 | 0084 |
| 20 0 | | | 0068 | 0070 | 0071 | 0073 | 0074 | 0075 | 0077 | 0078 | 0079 | 0081 | 0082 |
| 20 | | | 0067 | 0068 | 0069 | 0071 | 0072 | 0073 | 0075 | 0076 | 0077 | 0079 | 0080 |
| 40 | | | 0065 | 0066 | 0068 | 0069 | 0070 | 0072 | 0073 | 0074 | 0075 | 0077 | 0078 |
| 21 0 | | | 0063 | 0065 | 0066 | 0067 | 0068 | 0070 | 0071 | 0072 | 0074 | 0075 | 0076 |
| 20 | | | 0062 | 0063 | 0064 | 0065 | 0067 | 0068 | 0069 | 0070 | 0072 | 0073 | 0074 |
| 40 | | | 0060 | 0061 | 0063 | 0064 | 0065 | 0066 | 0067 | 0069 | 0070 | 0071 | 0072 |
| 22 0 | | | 0059 | 0060 | 0061 | 0062 | 0063 | 0065 | 0066 | 0067 | 0068 | 0069 | 0070 |
| 20 | | | 0057 | 0058 | 0059 | 0061 | 0062 | 0063 | 0064 | 0065 | 0066 | 0068 | 0069 |
| 40 | | | 0056 | 0057 | 0058 | 0059 | 0060 | 0061 | 0062 | 0064 | 0065 | 0066 | 0067 |
| 23 0 | | | 0054 | 0055 | 0057 | 0058 | 0059 | 0060 | 0061 | 0062 | 0063 | 0064 | 0065 |
| 20 | | | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 | 0060 | 0061 | 0063 | 0064 |
| 40 | | | 0052 | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 | 0060 | 0061 | 0062 |
| 24 0 | | | 0050 | 0051 | 0052 | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 | 0060 |
| 20 | | | | 0050 | 0051 | 0052 | 0053 | 0054 | 0055 | 0056 | 0057 | 0058 | 0059 |
| 40 | | | | 0049 | 0050 | 0051 | 0052 | 0053 | 0053 | 0054 | 0055 | 0056 | 0057 |
| 25 0 | | | | 0047 | 0048 | 0049 | 0050 | 0051 | 0052 | 0053 | 0054 | 0055 | 0056 |
| 20 | | | | 0046 | 0047 | 0048 | 0049 | 0050 | 0051 | 0052 | 0053 | 0053 | 0054 |
| 40 | | | | 0045 | 0046 | 0047 | 0048 | 0049 | 0049 | 0050 | 0051 | 0052 | 0053 |
| 26 0 | | | | 0044 | 0045 | 0046 | 0046 | 0047 | 0047 | 0048 | 0049 | 0050 | 0051 |
| 20 | | | | 0043 | 0043 | 0044 | 0045 | 0046 | 0047 | 0048 | 0048 | 0049 | 0050 |
| 40 | | | | 0041 | 0042 | 0043 | 0044 | 0045 | 0046 | 0046 | 0047 | 0048 | 0049 |
| 27 0 | | | | 0040 | 0041 | 0042 | 0043 | 0044 | 0044 | 0045 | 0046 | 0047 | 0047 |
| 20 | | | | 0039 | 0040 | 0041 | 0042 | 0042 | 0043 | 0044 | 0045 | 0045 | 0046 |
| 40 | | | | 0038 | 0039 | 0040 | 0040 | 0041 | 0042 | 0043 | 0043 | 0044 | 0045 |
| 28 0 | | | | 0037 | 0038 | 0039 | 0039 | 0040 | 0041 | 0042 | 0042 | 0043 | 0044 |

Log. D, for computing the First Correction of the Lunar Distance.

| App. alt. of moon. | 50′ | 51′ | 52′ | 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 28° 0′ | 0.0037 | 0.0038 | 0.0039 | 0.0039 | 0.0040 | 0.0041 | 0.0042 | 0.0042 | 0.0043 | 0.0044 | |
| 30 | 0.0036 | 0.0036 | 0.0037 | 0.0038 | 0.0038 | 0.0039 | 0.0040 | 0.0040 | 0.0041 | 0.0042 | |
| 29  0 | 0.0034 | 0.0035 | 0.0035 | 0.0036 | 0.0037 | 0.0037 | 0.0038 | 0.0039 | 0.0039 | 0.0040 | |
| 30 | 0.0033 | 0.0033 | 0.0034 | 0.0035 | 0.0035 | 0.0036 | 0.0036 | 0.0837 | 0.0038 | 0.0038 | |
| 30  0 | 0.0031 | 0.0032 | 0.0032 | 0.0033 | 0.0034 | 0.0034 | 0.0035 | 0.0035 | 0.0036 | 0.0037 | |
| 30 | 0.0030 | 0.0030 | 0.0031 | 0.0031 | 0.0032 | 0.0033 | 0.0033 | 0.0034 | 0.0034 | 0.0035 | |
| 31  0 | 0.0028 | 0.0029 | 0.0029 | 0.0030 | 0.0031 | 0.0031 | 0.0032 | 0.0032 | 0.0033 | 0.0033 | |
| 30 | 0.0027 | 0.0028 | 0.0028 | 0.0029 | 0.0029 | 0.0030 | 0.0030 | 0.0031 | 0.0031 | 0.0032 | 0.0032 |
| 32  0 | 0.0026 | 0.0026 | 0.0027 | 0.0027 | 0.0028 | 0.0028 | 0.0029 | 0.0029 | 0.0030 | 0.0030 | 0.0031 |
| 30 | 0.0024 | 0.0025 | 0.0025 | 0.0026 | 0.0026 | 0.0027 | 0.0027 | 0.0028 | 0.0028 | 0.0029 | 0.0029 |
| 33  0 | 0.0023 | 0.0024 | 0.0024 | 0.0025 | 0.0025 | 0.0025 | 0.0026 | 0.0026 | 0.0027 | 0.0027 | 0.0028 |
| 30 | 0.0022 | 0.0022 | 0.0023 | 0.0023 | 0.0024 | 0.0024 | 0.0025 | 0.0025 | 0.0025 | 0.0026 | 0.0026 |
| 34  0 | 0.0021 | 0.0021 | 0.0022 | 0.0022 | 0.0022 | 0.0023 | 0.0023 | 0.0024 | 0.0024 | 0.0024 | 0.0025 |
| 30 | 0.0020 | 0.0020 | 0.0020 | 0.0021 | 0.0021 | 0.0022 | 0.0022 | 0.0022 | 0.0023 | 0.0023 | 0.0023 |
| 35  0 | 0.0018 | 0.0019 | 0.0019 | 0.0020 | 0.0020 | 0.0020 | 0.0021 | 0.0021 | 0.0021 | 0.0022 | 0.0022 |
| 30 | 0.0017 | 0.0018 | 0.0018 | 0.0018 | 0.0019 | 0.0019 | 0.0019 | 0.0020 | 0.0020 | 0.0020 | 0.0021 |
| 36  0 | 0.0016 | 0.0017 | 0.0017 | 0.0017 | 0.0018 | 0.0018 | 0.0018 | 0.0019 | 0.0019 | 0.0019 | 0.0019 |
| 30 | 0.0015 | 0.0016 | 0.0016 | 0.0016 | 0.0016 | 0.0017 | 0.0017 | 0.0017 | 0.0018 | 0.0018 | 0.0018 |
| 37  0 | 0.0014 | 0.0014 | 0.0015 | 0.0015 | 0.0015 | 0.0016 | 0.0016 | 0.0016 | 0.0016 | 0.0017 | 0.0017 |
| 30 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0015 | 0.0015 | 0.0015 | 0.0015 | 0.0016 |
| 38  0 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0013 | 0.0014 | 0.0014 | 0.0014 | 0.0014 | 0.0014 |
| 30 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0012 | 0.0012 | 0.0013 | 0.0013 | 0.0013 | 0.0013 |
| 39  0 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0011 | 0.0011 | 0.0011 | 0.0012 | 0.0012 | 0.0012 | 0.0012 |
| 30 | | 0.0009 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0011 | 0.0011 | 0.0011 |
| 40 | | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0009 | 0.0010 | 0.0010 | 0.0010 |
| 41 | | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0007 | 0.0008 | 0.0008 |
| 42 | | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0005 | 0.0006 |
| 43 | | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0004 |
| 44 | | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| 45 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 46 | | 9.9998 | 9.9998 | 9.9998 | 9.9998 | 9.9998 | 9.9998 | 9.9998 | 9.9998 | 9.9998 | 9.9998 |
| 47 | | 9.9997 | 9.9997 | 9.9997 | 9.9997 | 9.9996 | 9.9996 | 9.9996 | 9.9996 | 9.9996 | 9.9996 |
| 48 | | 9.9995 | 9.9995 | 9.9995 | 9.9995 | 9.9995 | 9.9995 | 9.9995 | 9.9995 | 9.9994 | 9.9994 |
| 49 | | 9.9994 | 9.9994 | 9.9994 | 9.9994 | 9.9993 | 9.9993 | 9.9993 | 9.9993 | 9.9993 | 9.9993 |
| 50 | | 9.9992 | 9.9992 | 9.9992 | 9.9992 | 9.9992 | 9.9992 | 9.9992 | 9.9991 | 9.9991 | 9.9991 |
| 51 | | 9.9991 | 9.9991 | 9.9991 | 9.9991 | 9.9990 | 9.9990 | 9.9990 | 9.9990 | 9.9990 | 9.9990 |
| 52 | | 9.9990 | 9.9990 | 9.9990 | 9.9989 | 9.9989 | 9.9989 | 9.9989 | 9.9989 | 9.9988 | 9.9988 |
| 53 | | 9.9989 | 9.9988 | 9.9988 | 9.9988 | 9.9988 | 9.9988 | 9.9987 | 9.9987 | 9.9987 | 9.9987 |
| 54 | | 9.9988 | 9.9987 | 9.9987 | 9.9987 | 9.9987 | 9.9986 | 9.9986 | 9.9986 | 9.9986 | 9.9985 |
| 55 | | 9.9986 | 9.9986 | 9.9986 | 9.9986 | 9.9985 | 9.9985 | 9.9985 | 9.9984 | 9.9984 | 9.9984 |
| 56 | | 9.9985 | 9.9985 | 9.9985 | 9.9984 | 9.9984 | 9.9984 | 9.9984 | 9.9983 | 9.9983 | 9.9983 |
| 57 | | 9.9984 | 9.9984 | 9.9984 | 9.9983 | 9.9983 | 9.9983 | 9.9982 | 9.9982 | 9.9982 | 9.9981 |
| 58 | | 9.9983 | 9.9983 | 9.9983 | 9.9982 | 9.9982 | 9.9982 | 9.9981 | 9.9981 | 9.9981 | 9.9980 |
| 59 | | 9.9982 | 9.9982 | 9.9981 | 9.9981 | 9.9981 | 9.9980 | 9.9980 | 9.9980 | 9.9979 | 9.9979 |
| 60 | | 9.9981 | 9.9981 | 9.9980 | 9.9980 | 9.9980 | 9.9979 | 9.9979 | 9.9979 | 9.9978 | 9.9978 |
| 61 | | 9.9980 | 9.9980 | 9.9980 | 9.9979 | 9.9979 | 9.9978 | 9.9978 | 9.9978 | 9.9977 | 9.9977 |
| 62 | | 9.9979 | 9.9979 | 9.9979 | 9.9978 | 9.9978 | 9.9977 | 9.9977 | 9.9977 | 9.9976 | 9.9976 |
| 63 | | 9.9979 | 9.9978 | 9.9978 | 9.9977 | 9.9977 | 9.9976 | 9.9976 | 9.9976 | 9.9975 | 9.9975 |
| 64 | | 9.9978 | 9.9977 | 9.9977 | 9.9976 | 9.9976 | 9.9976 | 9.9975 | 9.9975 | 9.9974 | 9.9974 |
| 65 | | 9.9977 | 9.9977 | 9.9976 | 9.9976 | 9.9975 | 9.9975 | 9.9974 | 9.9974 | 9.9973 | 9.9972 |
| 66 | | 9.9976 | 9.9976 | 9.9975 | 9.9975 | 9.9974 | 9.9974 | 9.9973 | 9.9973 | 9.9973 | 9.9972 |
| 67 | | 9.9976 | 9.9975 | 9.9975 | 9.9974 | 9.9974 | 9.9973 | 9.9973 | 9.9972 | 9.9972 | 9.9971 |
| 68 | | 9.9975 | 9.9974 | 9.9974 | 9.9973 | 9.9973 | 9.9972 | 9.9972 | 9.9971 | 9.9971 | 9.9970 |
| 69 | | 9.9974 | 9.9974 | 9.9973 | 9.9973 | 9.9972 | 9.9972 | 9.9971 | 9.9971 | 9.9970 | 9.9970 |
| 70 | | 9.9974 | 9.9973 | 9.9973 | 9.9972 | 9.9972 | 9.9971 | 9.9970 | 9.9970 | 9.9969 | 9.9969 |
| 72 | | 9.9972 | 9.9972 | 9.9971 | 9.9971 | 9.9970 | 9.9970 | 9.9969 | 9.9969 | 9.9968 | 9.9968 |
| 74 | | 9.9971 | 9.9971 | 9.9970 | 9.9970 | 9.9969 | 9.9969 | 9.9968 | 9.9968 | 9.9967 | 9.9966 |
| 76 | | 9.9971 | 9.9970 | 9.9969 | 9.9969 | 9.9968 | 9.9968 | 9.9967 | 9.9966 | 9.9966 | 9.9965 |
| 78 | | 9.9970 | 9.9969 | 9.9969 | 9.9968 | 9.9967 | 9.9967 | 9.9966 | 9.9966 | 9.9965 | 9.9964 |
| 80 | | 9.9969 | 9.9969 | 9.9968 | 9.9967 | 9.9967 | 9.9966 | 9.9965 | 9.9965 | 9.9964 | 9.9964 |
| 90 | | 9.9968 | 9.9967 | 9.9966 | 9.9966 | 9.9965 | 9.9964 | 9.9964 | 9.9963 | 9.9963 | 9.9962 |

# APPENDIX V: TABLE VI.

## Second Correction of the Lunar Distance.

| Apparent distance. | 3′ | 7′ | 10 | 12′ | 14′ | 16′ | 18′ | 20′ | 21′ | 22′ | 23′ | 24′ | 25′ | 26′ | 27′ | 28′ | Apparent distance. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub. | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | Add. |
| 15° 0′ | 0 | 2 | 3 | 5 | 6 | 8 | 11 | 13 | 14 | 16 | 17 | 19 | 20 | 22 | 24 | 26 | |
| 30 | 0 | 2 | 3 | 5 | 6 | 8 | 10 | 13 | 14 | 15 | 17 | 18 | 20 | 21 | 23 | 25 | |
| 16 0 | 0 | 1 | 3 | 4 | 6 | 8 | 10 | 12 | 13 | 15 | 16 | 18 | 19 | 21 | 22 | 24 | |
| 30 | 0 | 1 | 3 | 4 | 6 | 8 | 10 | 12 | 13 | 14 | 16 | 17 | 18 | 20 | 21 | 23 | |
| 17 0 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 11 | 13 | 14 | 15 | 16 | 18 | 19 | 21 | 22 | |
| 30 | 0 | 1 | 3 | 4 | 5 | 7 | 9 | 11 | 12 | 13 | 15 | 16 | 17 | 19 | 20 | 22 | |
| 18 0 | 0 | 1 | 3 | 4 | 5 | 7 | 9 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 20 | 21 | |
| 30 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 10 | 12 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | |
| 19 0 | 0 | 1 | 3 | 4 | 5 | 6 | 8 | 10 | 11 | 12 | 13 | 15 | 16 | 17 | 18 | 20 | |
| 30 | 0 | 1 | 2 | 4 | 5 | 6 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 19 | |
| 20 0 | 0 | 1 | 2 | 3 | 5 | 6 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | |
| 21 | 0 | 1 | 2 | 3 | 4 | 6 | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | |
| 22 | 0 | 1 | 2 | 3 | 4 | 6 | 7 | 9 | 10 | 10 | 11 | 12 | 14 | 15 | 16 | 17 | |
| 23 | 0 | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
| 24 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| 25 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| 26 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 14 | |
| 27 | 0 | 1 | 2 | 2 | 3 | 4 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 12 | 13 | |
| 28 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | |
| 29 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | |
| 30 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | |
| 31 | 0 | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | |
| 32 | 0 | 1 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | |
| 33 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 11 | |
| 34 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | |
| 35 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 8 | 9 | 10 | |
| 36 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | |
| 37 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | |
| 38 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | |
| 39 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | |
| 40 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 140° |
| 42 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 138 |
| 44 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 136 |
| 46 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 134 |
| 48 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 132 |
| 50 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 130 |
| 52 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 128 |
| 54 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 126 |
| 56 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 124 |
| 58 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 122 |
| 60 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 120 |
| 62 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 118 |
| 64 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 116 |
| 66 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 114 |
| 68 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 112 |
| 70 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 110 |
| 74 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 106 |
| 78 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 102 |
| 82 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 98 |
| 86 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 94 |
| 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 90 |
| Apparent distance. | 3′ | 7′ | 10′ | 12′ | 14′ | 16′ | 18′ | 20′ | 21′ | 22′ | 23′ | 24′ | 25′ | 26′ | 27′ | 28′ | Apparent distance. |

First correction of distance.

## Second Correction of the Lunar Distance.

| Apparent distance. | First correction of distance. | | | | | | | | | | | | | | | | Apparent distance. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 29′ | 30′ | 31′ | 32′ | 33′ | 34′ | 35′ | 36′ | 37′ | 38′ | 39′ | 40′ | 41′ | 42′ | 43′ | 44′ | |
| Sub. | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | Add. |
| 15° 0′ | 27 | 29 | 31 | 33 | 35 | 38 | 40 | 42 | 45 | 47 | 50 | 52 | 55 | 57 | 60 | 63 | |
| 30 | 26 | 28 | 30 | 32 | 34 | 36 | 39 | 41 | 43 | 45 | 48 | 50 | 53 | 56 | 58 | 61 | |
| 16 0 | 26 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 42 | 44 | 46 | 49 | 51 | 54 | 56 | 59 | |
| 30 | 25 | 27 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 43 | 45 | 47 | 50 | 52 | 54 | 57 | |
| 17 0 | 24 | 26 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 46 | 48 | 50 | 53 | 55 | |
| 30 | 23 | 25 | 27 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 47 | 49 | 51 | 54 | |
| 18 0 | 23 | 24 | 26 | 28 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 50 | 52 | |
| 30 | 22 | 23 | 25 | 27 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 | 50 | |
| 19 0 | 21 | 23 | 24 | 26 | 28 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | |
| 30 | 21· | 22 | 24 | 25 | 27 | 28 | 30 | 32 | ·34 | 36 | ·37 | 39 | 41 | 43 | 46 | 48 | |
| 20 | 20 | 22 | 23 | 25 | 26 | 28 | 29 | 31 | 33 | 35 | 36 | 38 | 40 | 42 | 44 | 46 | |
| 21 | 19 | 20 | 22 | 23 | 25 | 26 | 28 | 29 | 31 | 33 | 35 | 36 | 38 | 40 | 42 | 44 | |
| 22 | 18 | 19 | 21 | 22 | 24 | 25 | 26 | 28 | 30 | 31 | 33 | 35 | 36 | 38 | 40 | 42 | |
| 23 | 17 | 19 | 20 | 21 | 22 | 24 | 25 | 27 | 28 | 30 | 31 | 33 | 35 | 36 | 38 | 40 | |
| 24 | 16 | 18 | 19 | 20 | 21 | 23 | 24 | 25 | 27 | 28 | 30 | 31 | 33 | 35 | 36 | 38 | |
| 25 | 16 | 17 | 18 | 19 | 20 | 22 | 23 | 24 | 26 | 27 | 28 | 30 | 31 | 33 | 35 | 36 | |
| 26 | 15 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 25 | 26 | 27 | 29 | 30 | 32 | 33 | 35 | |
| 27 | 14 | 15 | 16 | 18 | 19 | 20 | 21 | 23 | 24 | 25 | 26 | 27 | 29 | 30 | 32 | 33 | |
| 28 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | ·21 | 22 | 24 | 25 | 26 | 28 | 29 | 30 | 32 | |
| 29 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 23 | 24 | 25 | 26 | 28 | 29 | 30 | |
| 30 | 13 | 14 | 14 | 15 | 16 | 17 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 | 28 | 29 | |
| 31 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 26 | 27 | 28 | |
| 32 | 12 | 13 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 25 | 26 | 27 | |
| 33 | 11 | 12 | 13 | 14 | 15 | 16 | 16 | 17 | 18 | 19 | 20 | 22 | 23 | 24 | 25 | 26 | |
| 34 | 11 | 12 | 12 | 13 | 14′ | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | |
| 35 | 10 | 11 | 12 | 13 | 14 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | |
| 36 | 10 | 11 | 12 | 12 | 13 | 14 | 15 | 16 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | |
| 37 | 10 | 10 | 11 | 12 | 13 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | |
| 38 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | |
| 39 | 9 | 10 | 10 | 11 | 12 | 12 | 13 | 14 | 15 | 16 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 40 | 9 | 9 | 10 | 11 | 11 | 12 | 13 | 13 | 14 | 15 | 16 | 17 | 17 | 18 | 19 | 20 | 140° |
| 42 | 8 | 9 | 9 | 10 | 11 | 11 | 12 | 13 | 13 | 14 | 15 | 16 | 16 | 17 | 18 | 19 | 138 |
| 44 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 12 | 12 | 13 | 14 | 14 | 15 | 16 | 17 | 17 | 136 |
| 46 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 12 | 12 | 13 | 13 | 14 | 15 | 16 | 16 | 134 |
| 48 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 13 | 13 | 14 | 15 | 15 | 132 |
| 50 | 6 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 10 | 11 | 11 | 12 | 12 | 13 | 14 | 14 | 130 |
| 52 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 13 | 13 | 128 |
| 54 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 126 |
| 56 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 124 |
| 58 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 122 |
| 60 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 10 | 120 |
| 62 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 118 |
| 64 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 8 | 8 | 116 |
| 66 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 8 | 114 |
| 68 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 112 |
| 70 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 110 |
| 74 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 106 |
| 78 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 102 |
| 82 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2˙ | 98 |
| 86 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ·1 | 94 |
| 90° | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 90° |
| Apparent distance. | 29′ | 30′ | 31′ | 32′ | 33′ | 34′ | 35′ | 36′ | 37′ | 38′ | 39′ | 40′ | 41′ | 42′ | 43′ | 44′ | Apparent distance. |

First correction of distance.

# APPENDIX V: TABLE VI.

## Second Correction of the Lunar Distance.

| Appar-ent dis-tance. | First correction of distance. | | | | | | | | | | | | | | | | Appar-ent dis-tance. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45′ | 46′ | 47′ | 48′ | 49′ | 50′ | 51′ | 52′ | 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | |
| Sub. | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | Add. |
| 15° 0′ | 66 | 69 | 72 | 75 | 78 | 81 | 85 | 88 | 91 | 95 | 99 | 102 | 106 | 110 | 113 | 117 | |
| 30 | 64 | 67 | 70 | 72 | 76 | 79 | 82 | 85 | 88 | 92 | 95 | 99 | 102 | 106 | 110 | 113 | |
| 16  0 | 62 | 64 | 67 | 70 | 73 | 76 | 79 | 82 | 85 | 89 | 92 | 95 | 99 | 102 | 106 | 110 | |
| 30 | 60 | 62 | 65 | 68 | 71 | 74 | 77 | 80 | 83 | 86 | 89 | 92 | 96 | 99 | 103 | 106 | |
| 17  0 | 58 | 60 | 63 | 66 | 69 | 71 | 74 | 77 | 80 | 83 | 86 | 90 | 93 | 96 | 99 | 103 | |
| 30 | 56 | 59 | 61 | 64 | 66 | 69 | 72 | 75 | 78 | 81 | 84 | 87 | 90 | 93 | 96 | 100 | |
| 18  0 | 54 | 57 | 59 | 62 | 64 | 67 | 70 | 73 | 75 | 78 | 81 | 84 | ·87 | 90 | 94 | 97 | |
| 30 | 53 | 55 | 58 | 60 | 63 | 65 | 68 | 71 | 73 | 76 | 79 | 82 | 85 | 88 | 91 | 94 | |
| 19  0 | 51 | 54 | 56 | 58 | 61 | 63 | 66 | 69 | 71 | 74 | 77 | 79 | 82 | 85 | 88 | 91 | |
| 30 | 50 | 52 | 54 | 57 | 59 | 62 | 64 | 67 | 69 | 72 | 75 | 77 | 80 | 83 | 86 | 89 | |
| 20 | 49 | 51 | 53 | 55 | 58 | 60 | 62 | 65 | 67 | 70 | 73 | 75 | 78 | 81 | 83 | 86 | |
| 21 | 46 | 48 | 50 | 52 | 55 | 57 | 59 | 61 | 64 | 66 | 69 | 71 | 74 | 76 | 79 | 82 | |
| 22 | 44 | 46 | 48 | 50 | 52 | 54 | 56 | 58 | 61 | 63 | 65 | 68 | 70 | 73 | 75 | 78 | |
| 23 | 42 | 44 | 45 | 47 | 49 | 51 | 53 | 56 | 58 | 60 | 62 | 64 | 67 | 69 | 72 | 74 | |
| 24 | 40 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 64 | 66 | 68 | 71 | |
| 25 | 38 | 40 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 | 65 | 67 | |
| 26 | 36 | 38 | 40 | 41 | 43 | 45 | 47 | 48 | 50 | 52 | 54 | 56 | 58 | 60 | 62 | 64 | |
| 27 | 35 | 36 | 38 | 39 | 41 | 43 | 45 | 46 | 48 | 50 | 52 | 54 | 56 | 58 | 60 | 62 | |
| 28 | 33 | 35 | 36 | 38 | 39 | 41 | 43 | 44 | 46 | 48 | 50 | 51 | 53 | 55 | 57 | 59 | |
| 29 | 32 | 33 | 35 | 36 | 38 | 39 | 41 | 43 | 44 | 46 | 48 | 49 | 51 | 53 | 55 | 57 | |
| 30 | 31 | 32 | 33 | 35 | 36 | 38 | 39 | 41 | 42 | 44 | 46 | 47 | 49 | 51 | 53 | 54 | |
| 31 | 29 | 31 | 32 | 33 | 35 | 36 | 38 | 39 | 41 | 42 | 44 | 46 | 47 | 49 | 51 | 52 | |
| 32 | 28 | 30 | 31 | 32 | 34 | 35 | 36 | 38 | 39 | 41 | 42 | 44 | 45 | 47 | 49 | 50 | |
| 33 | 27 | 28 | 30 | 31 | 32 | 34 | 35 | 36 | 38 | 39 | 41 | 42 | 44 | 45 | 47 | 48 | |
| 34 | 26 | 27 | 29 | 30 | 31 | 32 | 34 | 35 | 36 | 38 | 39 | 41 | 42 | 44 | 45 | 47 | |
| 35 | 25 | 26 | 28 | 29 | 30 | 31 | 32 | 34 | 35 | 36 | 38 | 39 | 40 | 42 | 43 | 45 | |
| 36 | 24 | 25 | 27 | 28 | 29 | 30 | 31 | 32 | 34 | 35 | 36 | 38 | 39 | 40 | 42 | 43 | |
| 37 | 23 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 34 | 35 | 36 | 38 | 39 | 40 | 42 | |
| 38 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 34 | 35 | 36 | 38 | 39 | 40 | |
| 39 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 34 | 35 | 36 | 38 | 39 | |
| 40 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 34 | 35 | 36 | 37 | 140° |
| 42 | 20 | 21 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 34 | 35 | 138 |
| 44 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 33 | 136 |
| 46 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 29 | 30 | 134 |
| 48 | 16 | 17 | 17 | 18 | 19 | 20 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 132 |
| 50 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 25 | 25 | 26 | 130 |
| 52 | 14 | 14 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 25 | 128 |
| 54 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 126 |
| 56 | 12 | 12 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 124 |
| 58 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 122 |
| 60 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 120 |
| 62 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 118 |
| 64 | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 116 |
| 66 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 114 |
| 68 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 13 | 112 |
| 70 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 11 | 110 |
| 74 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 106 |
| 78 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 7 | 102 |
| 82 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 98 |
| 86 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 94 |
| 90° | 0 | 0 | 0 | 0 | 0 | 0 | .0 | 0 | 0 | 0 | 0 | 0 | 0· | 0 | 0 | 0 | 90° |
| Appar-ent dis-tance. | 45′ | 46′ | 47′ | 48′ | 49′ | 50′ | 51′ | 52′ | 53′ | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | Appar-ent dis-tance. |
| | First correction of distance. | | | | | | | | | | | | | | | | |

For finding the Correction of the Lunar Distance for the Contraction of the Moon's Semidiameter.

## TABLE VII A.—GIVING THE ARGUMENT FOR TABLE VII B.

| Red. P. and R. of moon. | Apparent altitude of moon. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5° | 5½° | 6° | 6½° | 7° | 7½° | 8° | 8½° | 9° | 9½° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 20° | 25° | 30° | 40° | 50° |
| 41′ | 65 | 56 | | | | | | | | | | | | | | | | | | | | | | |
| 42 | 63 | 54 | 47 | 41 | | | | | | | | | | | | | | | | | | | | |
| 43 | 62 | 53 | 46 | 40 | 35 | | | | | | | | | | | | | | | | | | | |
| 44 | 60 | 51 | 45 | 39 | 34 | 30 | 27 | | | | | | | | | | | | | | | | | |
| 45 | 58 | 50 | 43 | 38 | 33 | 30 | 26 | 24 | 21 | 20 | | | | | | | | | | | | | | |
| 46 | 57 | 49 | 42 | 37 | 33 | 29 | 26 | 23 | 21 | 19 | 17 | 15 | | | | | | | | | | | | |
| 47 | 56 | 48 | 41 | 36 | 32 | 28 | 25 | 23 | 20 | 19 | 17 | 14 | 12 | 10 | | | | | | | | | | |
| 48 | 54 | 46 | 40 | 35 | 31 | 28 | 25 | 22 | 20 | 18 | 17 | 14 | 12 | 10 | 9 | 8 | 7 | 6 | | | | | | |
| 49 | 53 | 45 | 39 | 35 | 30 | 27 | 24 | 22 | 19 | 18 | 16 | 14 | 12 | 10 | 9 | 8 | 7 | 6 | 6 | 5 | 3 | | | |
| 50 | 52 | 44 | 38 | 34 | 30 | 26 | 24 | 21 | 19 | 17 | 16 | 13 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 5 | 3 | 3 | 2 | |
| 51 | 50 | 43 | 38 | 33 | 29 | 26 | 23 | 21 | 19 | 17 | 15 | 13 | 11 | 10 | 8 | 7 | 7 | 6 | 5 | 5 | 3 | 2 | 2 | 2 |
| 52 | 49 | 42 | 37 | 32 | 28 | 25 | 23 | 20 | 18 | 17 | 15 | 13 | 11 | 9 | 8 | 7 | 7 | 6 | 5 | 4 | 3 | 2 | 2 | 2 |
| 53 | 48 | 41 | 36 | 32 | 28 | 25 | 22 | 20 | 18 | 16 | 15 | 12 | 11 | 9 | 8 | 7 | 6 | 6 | 5 | 4 | 3 | 2 | 2 | 2 |
| 54 | 47 | 41 | 35 | 31 | 27 | 24 | 22 | 19 | 18 | 16 | 15 | 12 | 10 | 9 | 8 | 7 | 6 | 6 | 5 | 4 | 3 | 2 | 2 | 2 |
| 55 | | | 35 | 30 | 27 | 24 | 21 | 19 | 17 | 16 | 14 | 12 | 10 | 9 | 8 | 7 | 6 | 6 | 5 | 4 | 3 | 2 | 2 | 2 |
| 56 | | | | 26 | 23 | 21 | 19 | 17 | 15 | 14 | 12 | 10 | 10 | 9 | 8 | 7 | 6 | 5 | 5 | 4 | 3 | 2 | 2 | 2 |
| 57 | | | | | | | 18 | 17 | 15 | 14 | 12 | 10 | 9 | 9 | 7 | 7 | 6 | 5 | 5 | 4 | 3 | 2 | 2 | 2 |
| 58 | | | | | | | | | | | 13 | 11 | 10 | 8 | 7 | 7 | 6 | 5 | 5 | 4 | 3 | 2 | 2 | 2 |
| 59 | | | | | | | | | | | | | | 8 | 7 | 6 | 6 | 5 | 5 | 4 | 3 | 2 | 2 | 2 |
| 60 | | | | | | | | | | | | | | | | | | | | 4 | 3 | 2 | 2 | 2 |

## TABLE VII B.—CONTRACTION OF MOON'S SEMI-DIAMETER.

| Whole correction of moon. | Argument, number from Table VII A. | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 44 | 48 | 52 | 56 | 60 | 64 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 15 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| 20 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 5 |
| 22 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 6 |
| 24 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 8 | 8 | 9 |
| 26 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 8 | 8 | 8 | 9 | 9 |
| 28 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 8 | 8 | 8 | 9 | 9 | 10 |
| 30 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 12 |
| 32 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 13 |
| 34 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 36 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 12 | 13 | 15 | 16 | 17 |
| 38 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 40 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 12 | 12 | 13 | 14 | 15 | 17 | 18 | 19 | 20 |
| 42 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 13 | 14 | 16 | 17 | 18 | 20 | 21 | 23 |
| 44 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 12 | 13 | 14 | 15 | 15 | 17 | 19 | 20 | 22 | 23 | |
| 45 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 15 | 16 | 18 | 19 | 21 | 23 | 24 | |
| 46 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14 | 15 | 16 | 17 | 19 | 20 | 22 | 24 | | |
| 47 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 21 | 23 | 25 | | |
| 48 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 24 | 26 | | |
| 49 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 23 | 25 | | | |
| 50 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 24 | 26 | | | |
| 51 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 23 | 25 | 27 | | | |
| 52 | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 21 | 22 | 24 | 26 | | | | |
| 53 | 1 | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 25 | 27 | | | | |
| 54 | | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | 20 | 21 | 22 | 23 | 26 | | | | | |
| 55 | | | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 | 15 | 16 | 17 | 18 | 19 | 21 | 22 | | | | | | | |
| 56 | | | | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | 16 | | | | | | | | | | | |
| 57 | | | | | 4 | 5 | 7 | | | | | | | | | | | | | | | | | | | |

When the *nearer* limb is observed, *substract* this correction; when the *farther*, *add*.

# APPENDIX V: TABLE VIII.

For finding the Correction of the Lunar Distance for the Contraction of the Sun's Semidiameter.

## TABLE VIII A.—GIVING THE ARGUMENT FOR TABLE VIII B.

Apparent altitude of sun.

| Red. P. and R. of sun | 5° | 5½° | 6° | 6½° | 7° | 7½° | 8° | 8½° | 9° | 9½° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 20° | 25° | 30° | 40° | 50° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1′ 0″ | | | | | | | | | | | | | | | | | | | | | | | 22 | 18 |
| 30 | | | | | | | | | | | | | | | | | | | | | 30 | 34 | 24 | 29 |
| 2 0 | | | | | | | | | | | | | | | | | | | 35 | 37 | 42 | 46 | 46 | |
| 30 | | | | | | | | | | | | | | | | | 40 | 42 | 44 | 47 | 53 | 59 | | |
| 3 0 | | | | | | | | | | | | | | | 44 | 46 | 49 | 51 | 53 | 57 | | | | |
| 30 | | | | | | | | | | | | | | 45 | 48 | 51 | 54 | 57 | 60 | 62 | 67 | | | |
| 4 0 | | | | | | | | | 45 | 49 | 52 | 55 | 59 | 62 | 65 | 68 | | | | | | | | |
| 30 | | | | | | | | 47 | 49 | 51 | 55 | 59 | 63 | 66 | 70 | | | | | | | | | |
| 5 0 | | | | | | | 47 | 50 | 52 | 54 | 57 | 61 | 66 | 70 | 74 | | | | | | | | | |
| 30 | | | | | | 47 | 50 | 52 | 55 | 57 | 60 | 62 | 67 | 72 | | | | | | | | | | |
| 6 0 | | | | | 49 | 52 | 55 | 57 | 60 | 63 | 66 | 68 | 74 | | | | | | | | | | | |
| 30 | | | | 50 | 53 | 56 | 59 | 62 | 65 | 68 | 71 | 74 | | | | | | | | | | | | |
| 7 0 | | | 51 | 54 | 58 | 61 | 64 | 67 | 70 | 75 | | | | | | | | | | | | | | |
| 30 | | 55 | 58 | 62 | 65 | 69 | 72 | 75 | | | | | | | | | | | | | | | | |
| 8 0 | 55 | 59 | 62 | 66 | 70 | 73 | 77 | | | | | | | | | | | | | | | | | |
| 30 | 59 | 63 | 66 | 70 | 74 | 78 | | | | | | | | | | | | | | | | | | |
| 9 0 | 62 | 66 | 70 | 74 | 79 | | | | | | | | | | | | | | | | | | | |
| 30 | 66 | 70 | 74 | 79 | | | | | | | | | | | | | | | | | | | | |
| 10 0 | 69 | 74 | 78 | | | | | | | | | | | | | | | | | | | | | |
| 30 | 73 | 77 | | | | | | | | | | | | | | | | | | | | | | |
| 11 0 | 76 | 81 | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 80 | | | | | | | | | | | | | | | | | | | | | | | |

## TABLE VIII B.—CONTRACTION OF SUN'S SEMIDIAMETER.

Argument, number from Table VIII A.

| Whole correction of sun | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 46 | 48 | 50 | 52 | 54 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | 70 | 72 | 74 | 76 | 78 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 0 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 0 | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 30 | | | | | | | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| 3 0 | | | | | | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 30 | | | | | | | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 0 | | | | | | | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 20 | | | | | | | | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 |
| 40 | | | | | | | | 9 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 |
| 5 0 | | | | | | | | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 |
| 20 | | | | | | | | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 7 |
| 40 | | | | | | | | 12 | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 7 |
| 6 0 | | | | | | | | | | 13 | 12 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 8 |
| 20 | | | | | | | | | | 14 | 14 | 13 | 13 | 12 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 9 |
| 40 | | | | | | | | | | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 11 | 11 | 11 | 11 | 10 |
| 7 0 | | | | | | | | | | | 18 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 11 |
| 20 | | | | | | | | | | | 19 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 13 | 12 |
| 40 | | | | | | | | | | | | 20 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 14 | 14 |
| 8 0 | | | | | | | | | | | | 21 | 21 | 20 | 19 | 19 | 18 | 18 | 17 | 17 | 16 | 16 | 15 | 15 |
| 20 | | | | | | | | | | | | | | 22 | 21 | 20 | 20 | 19 | 18 | 18 | 17 | 17 | 16 | 16 |
| 40 | | | | | | | | | | | | | | 23 | 23 | 22 | 21 | 20 | 20 | 19 | 19 | 18 | 18 | 17 |
| 9 0 | | | | | | | | | | | | | | | 23 | 24 | 23 | 22 | 21 | 21 | 20 | 20 | 19 | 19 |
| 20 | | | | | | | | | | | | | | | | | 25 | 24 | 23 | 22 | 22 | 21 | 21 | 20 |
| 40 | | | | | | | | | | | | | | | | | | | 25 | 24 | 23 | 23 | 22 | 22 |
| 10 0 | | | | | | | | | | | | | | | | | | | | 26 | 25 | 24 | 24 | 23 |
| 20 | | | | | | | | | | | | | | | | | | | | 28 | 27 | 26 | 25 | 25 |
| 40 | | | | | | | | | | | | | | | | | | | | | 28 | 28 | 27 | 26 |
| 11 0 | | | | | | | | | | | | | | | | | | | | | | 29 | 27 | 28 |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | 30 |

*Subtract* this correction from the distance.

Logarithms of Small Arcs in Space or Time.

| Arc ° | Arc ' | Arc " | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0ʰ | 0ᵐ | 0ˢ | | 0.0000 | 0.3010 | 0.4771 | 0.6021 | 0.6990 | 0.7782 | 0.8451 | 0.9031 | 0.9542 |
| 0 | 0 | 10 | 1.0000 | 1.0414 | 1.0792 | 1.1139 | 1.1461 | 1.1761 | 1.2041 | 1.2304 | 1.2553 | 1.2788 |
| 0 | 0 | 20 | 1.3010 | 1.3222 | 1.3424 | 1.3617 | 1.3802 | 1.3979 | 1.4150 | 1.4314 | 1.4472 | 1.4624 |
| 0 | 0 | 30 | 1.4771 | 1.4914 | 1.5051 | 1.5185 | 1.5315 | 1.5441 | 1.5563 | 1.5682 | 1.5798 | 1.5911 |
| 0 | 0 | 40 | 1.6021 | 1.6128 | 1.6232 | 1.6335 | 1.6435 | 1.6532 | 1.6628 | 1.6721 | 1.6812 | 1.6902 |
| 0 | 0 | 50 | 1.6990 | 1.7076 | 1.7160 | 1.7243 | 1.7324 | 1.7404 | 1.7482 | 1.7559 | 1.7634 | 1.7709 |
| 0 | 1 | 0 | 1.7782 | 1.7853 | 1.7924 | 1.7993 | 1.8062 | 1.8129 | 1.8195 | 1.8261 | 1.8325 | 1.8388 |
| | 1 | 10 | 1.8451 | 1.8513 | 1.8573 | 1.8633 | 1.8692 | 1.8751 | 1.8808 | 1.8865 | 1.8921 | 1.8976 |
| | 1 | 20 | 1.9031 | 1.9085 | 1.9138 | 1.9191 | 1.9243 | 1.9294 | 1.9345 | 1.9395 | 1.9445 | 1.9494 |
| | 1 | 30 | 1.9542 | 1.9589 | 1.9638 | 1.9685 | 1.9731 | 1.9777 | 1.9823 | 1.9868 | 1.9912 | 1.9956 |
| | 1 | 40 | 2.0000 | 2.0043 | 2.0086 | 2.0128 | 2.0170 | 2.0212 | 2.0253 | 2.0294 | 2.0334 | 2.0374 |
| | 1 | 50 | 2.0414 | 2.0453 | 2.0492 | 2.0531 | 2.0569 | 2.0607 | 2.0645 | 2.0682 | 2.0719 | 2.0755 |
| 0 | 2 | 0 | 2.0792 | 2.0828 | 2.0864 | 2.0899 | 2.0934 | 2.0969 | 2.1004 | 2.1038 | 2.1072 | 2.1106 |
| | 2 | 10 | 2.1139 | 2.1173 | 2.1206 | 2.1239 | 2.1271 | 2.1303 | 2.1335 | 2.1367 | 2.1399 | 2.1430 |
| | 2 | 20 | 2.1461 | 2.1492 | 2.1523 | 2.1553 | 2.1584 | 2.1614 | 2.1644 | 2.1673 | 2.1703 | 2.1732 |
| | 2 | 30 | 2.1761 | 2.1790 | 2.1818 | 2.1847 | 2.1875 | 2.1903 | 2.1931 | 2.1959 | 2.1987 | 2.2014 |
| | 2 | 40 | 2.2041 | 2.2068 | 2.2095 | 2.2122 | 2.2148 | 2.2175 | 2.2201 | 2.2227 | 2.2253 | 2.2279 |
| | 2 | 50 | 2.2304 | 2.2330 | 2.2355 | 2.2380 | 2.2405 | 2.2430 | 2.2455 | 2.2480 | 2.2504 | 2.2529 |
| 0 | 3 | 0 | 2.2553 | 2.2577 | 2.2601 | 2.2625 | 2.2648 | 2.2672 | 2.2695 | 2.2718 | 2.2742 | 2.2765 |
| | 3 | 10 | 2.2788 | 2.2810 | 2.2833 | 2.2856 | 2.2878 | 2.2900 | 2.2923 | 2.2945 | 2.2967 | 2.2989 |
| | 3 | 20 | 2.3010 | 2.3032 | 2.3054 | 2.3075 | 2.3096 | 2.3118 | 2.3139 | 2.3160 | 2.3181 | 2.3201 |
| | 3 | 30 | 2.3222 | 2.3243 | 2.3263 | 2.3284 | 2.3304 | 2.3324 | 2.3345 | 2.3365 | 2.3385 | 2.3404 |
| | 3 | 40 | 2.3424 | 2.3444 | 2.3464 | 2.3483 | 2.3502 | 2.3522 | 2.3541 | 2.3560 | 2.3579 | 2.3598 |
| | 3 | 50 | 2.3617 | 2.3636 | 2.3655 | 2.3674 | 2.3692 | 2.3711 | 2.3729 | 2.3747 | 2.3766 | 2.3784 |
| 0 | 4 | 0 | 2.3802 | 2.3820 | 2.3838 | 2.3856 | 2.3874 | 2.3892 | 2.3909 | 2.3927 | 2.3945 | 2.3962 |
| | 4 | 10 | 2.3979 | 2.3997 | 2.4014 | 2.4031 | 2.4048 | 2.4065 | 2.4082 | 2.4099 | 2.4116 | 2.4133 |
| | 4 | 20 | 2.4150 | 2.4166 | 2.4183 | 2.4200 | 2.4216 | 2.4232 | 2.4249 | 2.4265 | 2.4281 | 2.4298 |
| | 4 | 30 | 2.4314 | 2.4330 | 2.4346 | 2.4362 | 2.4378 | 2.4393 | 2.4409 | 2.4425 | 2.4440 | 2.4456 |
| | 4 | 40 | 2.4472 | 2.4487 | 2.4502 | 2.4518 | 2.4533 | 2.4548 | 2.4564 | 2.4579 | 2.4594 | 2.4609 |
| | 4 | 50 | 2.4624 | 2.4639 | 2.4654 | 2.4669 | 2.4683 | 2.4698 | 2.4713 | 2.4728 | 2.4742 | 2.4757 |
| 0 | 5 | 0 | 2.4771 | 2.4786 | 2.4800 | 2.4814 | 2.4829 | 2.4843 | 2.4857 | 2.4871 | 2.4886 | 2.4900 |
| | 5 | 10 | 2.4914 | 2.4928 | 2.4942 | 2.4955 | 2.4969 | 2.4983 | 2.4997 | 2.5011 | 2.5024 | 2.5038 |
| | 5 | 20 | 2.5051 | 2.5065 | 2.5079 | 2.5092 | 2.5105 | 2.5119 | 2.5132 | 2.5145 | 2.5159 | 2.5172 |
| | 5 | 30 | 2.5185 | 2.5198 | 2.5211 | 2.5224 | 2.5237 | 2.5250 | 2.5263 | 2.5276 | 2.5289 | 2.5302 |
| | 5 | 40 | 2.5315 | 2.5328 | 2.5340 | 2.5353 | 2.5366 | 2.5378 | 2.5391 | 2.5403 | 2.5416 | 2.5428 |
| | 5 | 50 | 2.5441 | 2.5453 | 2.5465 | 2.5478 | 2.5490 | 2.5502 | 2.5514 | 2.5527 | 2.5539 | 2.5551 |
| 0 | 6 | 0 | 2.5563 | 2.5575 | 2.5587 | 2.5599 | 2.5611 | 2.5623 | 2.5635 | 2.5647 | 2.5658 | 2.5670 |
| | 6 | 10 | 2.5682 | 2.5694 | 2.5705 | 2.5717 | 2.5729 | 2.5740 | 2.5752 | 2.5763 | 2.5775 | 2.5786 |
| | 6 | 20 | 2.5798 | 2.5809 | 2.5821 | 2.5832 | 2.5843 | 2.5855 | 2.5866 | 2.5877 | 2.5888 | 2.5899 |
| | 6 | 30 | 2.5911 | 2.5922 | 2.5933 | 2.5944 | 2.5955 | 2.5966 | 2.5977 | 2.5988 | 2.5999 | 2.6010 |
| | 6 | 40 | 2.6021 | 2.6031 | 2.6042 | 2.6053 | 2.6064 | 2.6075 | 2.6085 | 2.6096 | 2.6107 | 2.6117 |
| | 6 | 50 | 2.6128 | 2.6138 | 2.6149 | 2.6160 | 2.6170 | 2.6180 | 2.6191 | 2.6201 | 2.6212 | 2.6222 |
| 0 | 7 | 0 | 2.6232 | 2.6243 | 2.6253 | 2.6263 | 2.6274 | 2.6284 | 2.6294 | 2.6304 | 2.6314 | 2.6325 |
| | 7 | 10 | 2.6335 | 2.6345 | 2.6355 | 2.6365 | 2.6375 | 2.6385 | 2.6395 | 2.6405 | 2.6415 | 2.6425 |
| | 7 | 20 | 2.6435 | 2.6444 | 2.6454 | 2.6464 | 2.6474 | 2.6484 | 2.6493 | 2.6503 | 2.6513 | 2.6522 |
| | 7 | 30 | 2.6532 | 2.6542 | 2.6551 | 2.6561 | 2.6571 | 2.6580 | 2.6590 | 2.6599 | 2.6609 | 2.6618 |
| | 7 | 40 | 2.6628 | 2.6637 | 2.6646 | 2.6656 | 2.6665 | 2.6675 | 2.6684 | 2.6693 | 2.6702 | 2.6712 |
| | 7 | 50 | 2.6721 | 2.6730 | 2.6739 | 2.6749 | 2.6758 | 2.6767 | 2.6776 | 2.6785 | 2.6794 | 2.6803 |
| 0 | 8 | 0 | 2.6812 | 2.6821 | 2.6830 | 2.6839 | 2.6848 | 2.6857 | 2.6866 | 2.6875 | 2.6884 | 2.6893 |
| | 8 | 10 | 2.6902 | 2.6911 | 2.6920 | 2.6928 | 2.6937 | 2.6946 | 2.6955 | 2.6964 | 2.6972 | 2.6981 |
| | 8 | 20 | 2.6990 | 2.6998 | 2.7007 | 2.7016 | 2.7024 | 2.7033 | 2.7042 | 2.7050 | 2.7059 | 2.7067 |
| | 8 | 30 | 2.7076 | 2.7084 | 2.7093 | 2.7101 | 2.7110 | 2.7118 | 2.7126 | 2.7135 | 2.7143 | 2.7152 |
| | 8 | 40 | 2.7160 | 2.7168 | 2.7177 | 2.7185 | 2.7193 | 2.7202 | 2.7210 | 2.7218 | 2.7226 | 2.7235 |
| | 8 | 50 | 2.7243 | 2.7251 | 2.7259 | 2.7267 | 2.7275 | 2.7284 | 2.7292 | 2.7300 | 2.7308 | 2.7316 |
| 0 | 9 | 0 | 2.7324 | 2.7332 | 2.7340 | 2.7348 | 2.7356 | 2.7364 | 2.7372 | 2.7380 | 2.7388 | 2.7396 |
| | 9 | 10 | 2.7404 | 2.7412 | 2.7419 | 2.7427 | 2.7435 | 2.7443 | 2.7451 | 2.7459 | 2.7466 | 2.7474 |
| | 9 | 20 | 2.7482 | 2.7490 | 2.7497 | 2.7505 | 2.7513 | 2.7520 | 2.7528 | 2.7536 | 2.7543 | 2.7551 |
| | 9 | 30 | 2.7559 | 2.7566 | 2.7574 | 2.7582 | 2.7589 | 2.7597 | 2.7604 | 2.7612 | 2.7619 | 2.7627 |
| | 9 | 40 | 2.7634 | 2.7642 | 2.7649 | 2.7657 | 2.7664 | 2.7672 | 2.7679 | 2.7686 | 2.7694 | 2.7701 |
| | 9 | 50 | 2.7709 | 2.7716 | 2.7723 | 2.7731 | 2.7738 | 2.7745 | 2.7752 | 2.7760 | 2.7767 | 2.7774 |

# APPENDIX V: TABLE IX.

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 0ʰ 10ᵐ | | 0ˢ | 2.7782 | 2.7789 | 2.7796 | 2.7803 | 2.7810 | 2.7818 | 2.7825 | 2.7832 | 2.7839 | 2.7846 |
| | 10 | 10 | 2.7853 | 2.7860 | 2.7868 | 2.7875 | 2.7882 | 2.7889 | 2.7896 | 2.7903 | 2.7910 | 2.7917 |
| | 10 | 20 | 2.7924 | 2.7931 | 2.7938 | 2.7945 | 2.7952 | 2.7959 | 2.7966 | 2.7973 | 2.7980 | 2.7987 |
| | 10 | 30 | 2.7993 | 2.8000 | 2.8007 | 2.8014 | 2.8021 | 2.8028 | 2.8035 | 2.8041 | 2.8048 | 2.8055 |
| | 10 | 40 | 2.8062 | 2.8069 | 2.8075 | 2.8082 | 2.8089 | 2.8096 | 2.8102 | 2.8109 | 2.8116 | 2.8122 |
| | 10 | 50 | 2.8129 | 2.8136 | 2.8142 | 2.8149 | 2.8156 | 2.8162 | 2.8169 | 2.8176 | 2.8182 | 2.8189 |
| 0 | 11 | 0 | 2.8195 | 2.8202 | 2.8209 | 2.8215 | 2.8222 | 2.8228 | 2.8235 | 2.8241 | 2.8248 | 2.8254 |
| | 11 | 10 | 2.8261 | 2.8267 | 2.8274 | 2.8280 | 2.8287 | 2.8293 | 2.8299 | 2.8306 | 2.8312 | 2.8319 |
| | 11 | 20 | 2.8325 | 2.8331 | 2.8338 | 2.8344 | 2.8351 | 2.8357 | 2.8363 | 2.8370 | 2.8376 | 2.8382 |
| | 11 | 30 | 2.8388 | 2.8395 | 2.8401 | 2.8407 | 2.8414 | 2.8420 | 2.8426 | 2.8432 | 2.8439 | 2.8445 |
| | 11 | 40 | 2.8451 | 2.8457 | 2.8463 | 2.8470 | 2.8476 | 2.8482 | 2.8488 | 2.8494 | 2.8500 | 2.8506 |
| | 11 | 50 | 2.8513 | 2.8519 | 2.8525 | 2.8531 | 2.8537 | 2.8543 | 2.8549 | 2.8555 | 2.8561 | 2.8567 |
| 0 | 12 | 0 | 2.8573 | 2.8579 | 2.8585 | 2.8591 | 2.8597 | 2.8603 | 2.8609 | 2.8615 | 2.8621 | 2.8627 |
| | 12 | 10 | 2.8633 | 2.8639 | 2.8645 | 2.8651 | 2.8657 | 2.8663 | 2.8669 | 2.8675 | 2.8681 | 2.8686 |
| | 12 | 20 | 2.8692 | 2.8698 | 2.8704 | 2.8710 | 2.8716 | 2.8722 | 2.8727 | 2.8733 | 2.8739 | 2.8745 |
| | 12 | 30 | 2.8751 | 2.8756 | 2.8762 | 2.8768 | 2.8774 | 2.8779 | 2.8785 | 2.8791 | 2.8797 | 2.8802 |
| | 12 | 40 | 2.8808 | 2.8814 | 2.8820 | 2.8825 | 2.8831 | 2.8837 | 2.8842 | 2.8848 | 2.8854 | 2.8859 |
| | 12 | 50 | 2.8865 | 2.8871 | 2.8876 | 2.8882 | 2.8887 | 2.8893 | 2.8899 | 2.8904 | 2.8910 | 2.8915 |
| 0 | 13 | 0 | 2.8921 | 2.8927 | 2.8932 | 2.8938 | 2.8943 | 2.8949 | 2.8954 | 2.8960 | 2.8965 | 2.8971 |
| | 13 | 10 | 2.8976 | 2.8982 | 2.8987 | 2.8993 | 2.8998 | 2.9004 | 2.9009 | 2.9015 | 2.9020 | 2.9025 |
| | 13 | 20 | 2.9031 | 2.9036 | 2.9042 | 2.9047 | 2.9053 | 2.9058 | 2.9063 | 2.9069 | 2.9074 | 2.9079 |
| | 13 | 30 | 2.9085 | 2.9090 | 2.9096 | 2.9101 | 2.9106 | 2.9112 | 2.9117 | 2.9122 | 2.9128 | 2.9133 |
| | 13 | 40 | 2.9138 | 2.9143 | 2.9149 | 2.9154 | 2.9159 | 2.9165 | 2.9170 | 2.9175 | 2.9180 | 2.9186 |
| | 13 | 50 | 2.9191 | 2.9196 | 2.9201 | 2.9206 | 2.9212 | 2.9217 | 2.9222 | 2.9227 | 2.9232 | 2.9238 |
| 0 | 14 | 0 | 2.9243 | 2.9248 | 2.9253 | 2.9258 | 2.9263 | 2.9269 | 2.9274 | 2.9279 | 2.9284 | 2.9289 |
| | 14 | 10 | 2.9294 | 2.9299 | 2.9304 | 2.9309 | 2.9315 | 2.9320 | 2.9325 | 2.9330 | 2.9335 | 2.9340 |
| | 14 | 20 | 2.9345 | 2.9350 | 2.9355 | 2.9360 | 2.9365 | 2.9370 | 2.9375 | 2.9380 | 2.9385 | 2.9390 |
| | 14 | 30 | 2.9395 | 2.9400 | 2.9405 | 2.9410 | 2.9415 | 2.9420 | 2.9425 | 2.9430 | 2.9435 | 2.9440 |
| | 14 | 40 | 2.9445 | 2.9450 | 2.9455 | 2.9460 | 2.9465 | 2.9469 | 2.9474 | 2.9479 | 2.9484 | 2.9489 |
| | 14 | 50 | 2.9494 | 2.9499 | 2.9504 | 2.9509 | 2.9513 | 2.9518 | 2.9523 | 2.9528 | 2.9533 | 2.9538 |
| 0 | 15 | 0 | 2.9542 | 2.9547 | 2.9552 | 2.9557 | 2.9562 | 2.9566 | 2.9571 | 2.9576 | 2.9581 | 2.9586 |
| | 15 | 10 | 2.9590 | 2.9595 | 2.9600 | 2.9605 | 2.9609 | 2.9614 | 2.9619 | 2.9624 | 2.9628 | 2.9633 |
| | 15 | 20 | 2.9638 | 2.9643 | 2.9647 | 2.9652 | 2.9657 | 2.9661 | 2.9666 | 2.9671 | 2.9675 | 2.9680 |
| | 15 | 30 | 2.9685 | 2.9689 | 2.9694 | 2.9699 | 2.9703 | 2.9708 | 2.9713 | 2.9717 | 2.9722 | 2.9727 |
| | 15 | 40 | 2.9731 | 2.9736 | 2.9741 | 2.9745 | 2.9750 | 2.9754 | 2.9759 | 2.9763 | 2.9768 | 2.9773 |
| | 15 | 50 | 2.9777 | 2.9782 | 2.9786 | 2.9791 | 2.9795 | 2.9800 | 2.9805 | 2.9809 | 2.9814 | 2.9818 |
| 0 | 16 | 0 | 2.9823 | 2.9827 | 2.9832 | 2.9836 | 2.9841 | 2.9845 | 2.9850 | 2.9854 | 2.9859 | 2.9863 |
| | 16 | 10 | 2.9868 | 2.9872 | 2.9877 | 2.9881 | 2.9886 | 2.9890 | 2.9894 | 2.9899 | 2.9903 | 2.9908 |
| | 16 | 20 | 2.9912 | 2.9917 | 2.9921 | 2.9926 | 2.9930 | 2.9934 | 2.9939 | 2.9943 | 2.9948 | 2.9952 |
| | 16 | 30 | 2.9956 | 2.9961 | 2.9965 | 2.9969 | 2.9974 | 2.9978 | 2.9983 | 2.9987 | 2.9991 | 2.9996 |
| | 16 | 40 | 3.0000 | 3.0004 | 3.0009 | 3.0013 | 3.0017 | 3.0022 | 3.0026 | 3.0030 | 3.0035 | 3.0039 |
| | 16 | 50 | 3.0043 | 3.0048 | 3.0052 | 3.0056 | 3.0060 | 3.0065 | 3.0069 | 3.0073 | 3.0077 | 3.0082 |
| 0 | 17 | 0 | 3.0086 | 3.0090 | 3.0095 | 3.0099 | 3.0103 | 3.0107 | 3.0111 | 3.0116 | 3.0120 | 3.0124 |
| | 17 | 10 | 3.0128 | 3.0133 | 3.0137 | 3.0141 | 3.0145 | 3.0149 | 3.0154 | 3.0158 | 3.0162 | 3.0166 |
| | 17 | 20 | 3.0170 | 3.0175 | 3.0179 | 3.0183 | 3.0187 | 3.0191 | 3.0195 | 3.0199 | 3.0204 | 3.0208 |
| | 17 | 30 | 3.0212 | 3.0216 | 3.0220 | 3.0224 | 3.0228 | 3.0233 | 3.0237 | 3.0241 | 3.0245 | 3.0249 |
| | 17 | 40 | 3.0253 | 3.0257 | 3.0261 | 3.0265 | 3.0269 | 3.0273 | 3.0278 | 3.0282 | 3.0286 | 3.0290 |
| | 17 | 50 | 3.0294 | 3.0298 | 3.0302 | 3.0306 | 3.0310 | 3.0314 | 3.0318 | 3.0322 | 3.0326 | 3.0330 |
| 0 | 18 | 0 | 3.0334 | 3.0338 | 3.0342 | 3.0346 | 3.0350 | 3.0354 | 3.0358 | 3.0362 | 3.0366 | 3.0370 |
| | 18 | 10 | 3.0374 | 3.0378 | 3.0382 | 3.0386 | 3.0390 | 3.0394 | 3.0398 | 3.0402 | 3.0406 | 3.0410 |
| | 18 | 20 | 3.0414 | 3.0418 | 3.0422 | 3.0426 | 3.0430 | 3.0434 | 3.0438 | 3.0441 | 3.0445 | 3.0449 |
| | 18 | 30 | 3.0453 | 3.0457 | 3.0461 | 3.0465 | 3.0469 | 3.0473 | 3.0477 | 3.0481 | 3.0484 | 3.0488 |
| | 18 | 40 | 3.0492 | 3.0496 | 3.0500 | 3.0504 | 3.0508 | 3.0512 | 3.0515 | 3.0519 | 3.0523 | 3.0527 |
| | 18 | 50 | 3.0531 | 3.0535 | 3.0538 | 3.0542 | 3.0546 | 3.0550 | 3.0554 | 3.0558 | 3.0561 | 3.0565 |
| 0 | 19 | 0 | 3.0569 | 3.0573 | 3.0577 | 3.0580 | 3.0584 | 3.0588 | 3.0592 | 3.0596 | 3.0599 | 3.0603 |
| | 19 | 10 | 3.0607 | 3.0611 | 3.0615 | 3.0618 | 3.0622 | 3.0626 | 3.0630 | 3.0633 | 3.0637 | 3.0641 |
| | 19 | 20 | 3.0645 | 3.0648 | 3.0652 | 3.0656 | 3.0660 | 3.0663 | 3.0667 | 3.0671 | 3.0674 | 3.0678 |
| | 19 | 30 | 3.0682 | 3.0686 | 3.0689 | 3.0693 | 3.0697 | 3.0700 | 3.0704 | 3.0708 | 3.0711 | 3.0715 |
| | 19 | 40 | 3.0719 | 3.0722 | 3.0726 | 3.0730 | 3.0734 | 3.0737 | 3.0741 | 3.0745 | 3.0748 | 3.0752 |
| | 19 | 50 | 3.0755 | 3.0759 | 3.0763 | 3.0766 | 3.0770 | 3.0774 | 3.0777 | 3.0781 | 3.0785 | 3.0788 |

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °′″ | | | | | | | | | | | | |
| 0ʰ 20ᵐ | 0ˢ | | 3.0792 | 3.0795 | 3.0799 | 3.0803 | 3.0806 | 3.0810 | 3.0813 | 3.0817 | 3.0821 | 3.0824 |
| 20 | 10 | | 3.0828 | 3.0831 | 3.0835 | 3.0839 | 3.0842 | 3.0846 | 3.0849 | 3.0853 | 3.0856 | 3.0860 |
| 20 | 20 | | 3.0864 | 3.0867 | 3.0871 | 3.0874 | 3.0878 | 3.0881 | 3.0885 | 3.0888 | 3.0892 | 3.0896 |
| 20 | 30 | | 3.0899 | 3.0903 | 3.0906 | 3.0910 | 3.0913 | 3.0917 | 3.0920 | 3.0924 | 3.0927 | 3.0931 |
| 20 | 40 | | 3.0934 | 3.0938 | 3.0941 | 3.0945 | 3.0948 | 3.0952 | 3.0955 | 3.0959 | 3.0962 | 3.0966 |
| 20 | 50 | | 3.0969 | 3.0973 | 3.0976 | 3.0980 | 3.0983 | 3.0986 | 3.0990 | 3.0993 | 3.0997 | 3.1000 |
| 0 21 | 0 | | 3.1004 | 3.1007 | 3.1011 | 3.1014 | 3.1017 | 3.1021 | 3.1024 | 3.1028 | 3.1031 | 3.1035 |
| 21 | 10 | | 3.1038 | 3.1041 | 3.1045 | 3.1048 | 3.1052 | 3.1055 | 3.1059 | 3.1062 | 3.1065 | 3.1069 |
| 21 | 20 | | 3.1072 | 3.1075 | 3.1079 | 3.1082 | 3.1086 | 3.1089 | 3.1092 | 3.1096 | 3.1099 | 3.1103 |
| 21 | 30 | | 3.1106 | 3.1109 | 3.1113 | 3.1116 | 3.1119 | 3.1123 | 3.1126 | 3.1129 | 3.1133 | 3.1136 |
| 21 | 40 | | 3.1139 | 3.1143 | 3.1146 | 3.1149 | 3.1153 | 3.1156 | 3.1159 | 3.1163 | 3.1166 | 3.1169 |
| 21 | 50 | | 3.1173 | 3.1176 | 3.1179 | 3.1183 | 3.1186 | 3.1189 | 3.1193 | 3.1196 | 3.1199 | 3.1202 |
| 0 22 | 0 | | 3.1206 | 3.1209 | 3.1212 | 3.1216 | 3.1219 | 3.1222 | 3.1225 | 3.1229 | 3.1232 | 3.1235 |
| 22 | 10 | | 3.1239 | 3.1242 | 3.1245 | 3.1248 | 3.1252 | 3.1255 | 3.1258 | 3.1261 | 3.1265 | 3.1268 |
| 22 | 20 | | 3.1271 | 3.1274 | 3.1278 | 3.1281 | 3.1284 | 3.1287 | 3.1290 | 3.1294 | 3.1297 | 3.1300 |
| 22 | 30 | | 3.1303 | 3.1307 | 3.1310 | 3.1313 | 3.1316 | 3.1319 | 3.1323 | 3.1326 | 3.1329 | 3.1332 |
| 22 | 40 | | 3.1335 | 3.1339 | 3.1342 | 3.1345 | 3.1348 | 3.1351 | 3.1355 | 3.1358 | 3.1361 | 3.1364 |
| 22 | 50 | | 3.1367 | 3.1370 | 3.1374 | 3.1377 | 3.1380 | 3.1383 | 3.1386 | 3.1389 | 3.1392 | 3.1396 |
| 0 23 | 0 | | 3.1399 | 3.1402 | 3.1405 | 3.1408 | 3.1411 | 3.1414 | 3.1418 | 3.1421 | 3.1424 | 3.1427 |
| 23 | 10 | | 3.1430 | 3.1433 | 3.1436 | 3.1440 | 3.1443 | 3.1446 | 3.1449 | 3.1452 | 3.1455 | 3.1458 |
| 23 | 20 | | 3.1461 | 3.1464 | 3.1467 | 3.1471 | 3.1474 | 3.1477 | 3.1480 | 3.1483 | 3.1486 | 3.1489 |
| 23 | 30 | | 3.1492 | 3.1495 | 3.1498 | 3.1501 | 3.1504 | 3.1508 | 3.1511 | 3.1514 | 3.1517 | 3.1520 |
| 23 | 40 | | 3.1523 | 3.1526 | 3.1529 | 3.1532 | 3.1535 | 3.1538 | 3.1541 | 3.1544 | 3.1547 | 3.1550 |
| 23 | 50 | | 3.1553 | 3.1556 | 3.1559 | 3.1562 | 3.1565 | 3.1569 | 3.1572 | 3.1575 | 3.1578 | 3.1581 |
| 0 24 | 0 | | 3.1584 | 3.1587 | 3.1590 | 3.1593 | 3.1596 | 3.1599 | 3.1602 | 3.1605 | 3.1608 | 3.1611 |
| 24 | 10 | | 3.1614 | 3.1617 | 3.1620 | 3.1623 | 3.1626 | 3.1629 | 3.1632 | 3.1635 | 3.1638 | 3.1641 |
| 24 | 20 | | 3.1644 | 3.1647 | 3.1649 | 3.1652 | 3.1655 | 3.1658 | 3.1661 | 3.1664 | 3.1667 | 3.1670 |
| 24 | 30 | | 3.1673 | 3.1676 | 3.1679 | 3.1682 | 3.1685 | 3.1688 | 3.1691 | 3.1694 | 3.1697 | 3.1700 |
| 24 | 40 | | 3.1703 | 3.1706 | 3.1708 | 3.1711 | 3.1714 | 3.1717 | 3.1720 | 3.1723 | 3.1726 | 3.1729 |
| 24 | 50 | | 3.1732 | 3.1735 | 3.1738 | 3.1741 | 3.1744 | 3.1746 | 3.1749 | 3.1752 | 3.1755 | 3.1758 |
| 0 25 | 0 | | 3.1761 | 3.1764 | 3.1767 | 3.1770 | 3.1772 | 3.1775 | 3.1778 | 3.1781 | 3.1784 | 3.1787 |
| 25 | 10 | | 3.1790 | 3.1793 | 3.1796 | 3.1798 | 3.1801 | 3.1804 | 3.1807 | 3.1810 | 3.1813 | 3.1816 |
| 25 | 20 | | 3.1818 | 3.1821 | 3.1824 | 3.1827 | 3.1830 | 3.1833 | 3.1836 | 3.1838 | 3.1841 | 3.1844 |
| 25 | 30 | | 3.1847 | 3.1850 | 3.1853 | 3.1855 | 3.1858 | 3.1861 | 3.1864 | 3.1867 | 3.1870 | 3.1872 |
| 25 | 40 | | 3.1875 | 3.1878 | 3.1881 | 3.1884 | 3.1886 | 3.1889 | 3.1892 | 3.1895 | 3.1898 | 3.1901 |
| 25 | 50 | | 3.1903 | 3.1906 | 3.1909 | 3.1912 | 3.1915 | 3.1917 | 3.1920 | 3.1923 | 3.1926 | 3.1928 |
| 0 26 | 0 | | 3.1931 | 3.1934 | 3.1937 | 3.1940 | 3.1942 | 3.1945 | 3.1948 | 3.1951 | 3.1953 | 3.1956 |
| 26 | 10 | | 3.1959 | 3.1962 | 3.1965 | 3.1967 | 3.1970 | 3.1973 | 3.1976 | 3.1978 | 3.1981 | 3.1984 |
| 26 | 20 | | 3.1987 | 3.1989 | 3.1992 | 3.1995 | 3.1998 | 3.2000 | 3.2003 | 3.2006 | 3.2009 | 3.2011 |
| 26 | 30 | | 3.2014 | 3.2017 | 3.2019 | 3.2022 | 3.2025 | 3.2028 | 3.2030 | 3.2033 | 3.2036 | 3.2038 |
| 26 | 40 | | 3.2041 | 3.2044 | 3.2047 | 3.2049 | 3.2052 | 3.2055 | 3.2057 | 3.2060 | 3.2063 | 3.2066 |
| 26 | 50 | | 3.2068 | 3.2071 | 3.2074 | 3.2076 | 3.2079 | 3.2082 | 3.2084 | 3.2087 | 3.2090 | 3.2092 |
| 0 27 | 0 | | 3.2095 | 3.2098 | 3.2101 | 3.2103 | 3.2106 | 3.2109 | 3.2111 | 3.2114 | 3.2117 | 3.2119 |
| 27 | 10 | | 3.2122 | 3.2125 | 3.2127 | 3.2130 | 3.2133 | 3.2135 | 3.2138 | 3.2140 | 3.2143 | 3.2146 |
| 27 | 20 | | 3.2148 | 3.2151 | 3.2154 | 3.2156 | 3.2159 | 3.2162 | 3.2164 | 3.2167 | 3.2170 | 3.2172 |
| 27 | 30 | | 3.2175 | 3.2177 | 3.2180 | 3.2183 | 3.2185 | 3.2188 | 3.2191 | 3.2193 | 3.2196 | 3.2198 |
| 27 | 40 | | 3.2201 | 3.2204 | 3.2206 | 3.2209 | 3.2212 | 3.2214 | 3.2217 | 3.2219 | 3.2222 | 3.2225 |
| 27 | 50 | | 3.2227 | 3.2230 | 3.2232 | 3.2235 | 3.2238 | 3.2240 | 3.2243 | 3.2245 | 3.2248 | 3.2250 |
| 0 28 | 0 | | 3.2253 | 3.2256 | 3.2258 | 3.2261 | 3.2263 | 3.2266 | 3.2269 | 3.2271 | 3.2274 | 3.2276 |
| 28 | 10 | | 3.2279 | 3.2281 | 3.2284 | 3.2287 | 3.2289 | 3.2292 | 3.2294 | 3.2297 | 3.2299 | 3.2302 |
| 28 | 20 | | 3.2304 | 3.2307 | 3.2310 | 3.2312 | 3.2315 | 3.2317 | 3.2320 | 3.2322 | 3.2325 | 3.2327 |
| 28 | 30 | | 3.2330 | 3.2333 | 3.2335 | 3.2338 | 3.2340 | 3.2343 | 3.2345 | 3.2348 | 3.2350 | 3.2353 |
| 28 | 40 | | 3.2355 | 3.2358 | 3.2360 | 3.2363 | 3.2365 | 3.2368 | 3.2370 | 3.2373 | 3.2375 | 3.2378 |
| 28 | 50 | | 3.2380 | 3.2383 | 3.2385 | 3.2388 | 3.2390 | 3.2393 | 3.2395 | 3.2398 | 3.2400 | 3.2403 |
| 0 29 | 0 | | 3.2405 | 3.2408 | 3.2410 | 3.2413 | 3.2415 | 3.2418 | 3.2420 | 3.2423 | 3.2425 | 3.2428 |
| 29 | 10 | | 3.2430 | 3.2433 | 3.2435 | 3.2438 | 3.2440 | 3.2443 | 3.2445 | 3.2448 | 3.2450 | 3.2453 |
| 29 | 20 | | 3.2455 | 3.2458 | 3.2460 | 3.2463 | 3.2465 | 3.2467 | 3.2470 | 3.2472 | 3.2475 | 3.2477 |
| 29 | 30 | | 3.2480 | 3.2482 | 3.2485 | 3.2487 | 3.2490 | 3.2492 | 3.2494 | 3.2497 | 3.2499 | 3.2502 |
| 29 | 40 | | 3.2504 | 3.2507 | 3.2509 | 3.2512 | 3.2514 | 3.2516 | 3.2519 | 3.2521 | 3.2524 | 3.2526 |
| 29 | 50 | | 3.2529 | 3.2531 | 3.2533 | 3.2536 | 3.2538 | 3.2541 | 3.2543 | 3.2545 | 3.2548 | 3.2550 |

# APPENDIX V: TABLE IX.

### Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0ʰ | 30ᵐ | 0ˢ | 3. 2553 | 3. 2555 | 3. 2558 | 3. 2560 | 3. 2562 | 3. 2565 | 3. 2567 | 3. 2570 | 3. 2572 | 3. 2574 |
| | 30 | 10 | 3. 2577 | 3. 2579 | 3. 2582 | 3. 2584 | 3. 2586 | 3. 2589 | 3. 2591 | 3. 2594 | 3. 2596 | 3. 2598 |
| | 30 | 20 | 3. 2601 | 3. 2603 | 3. 2605 | 3. 2608 | 3. 2610 | 3. 2613 | 3. 2615 | 3. 2617 | 3. 2620 | 3. 2622 |
| | 30 | 30 | 3. 2625 | 3. 2627 | 3. 2629 | 3. 2632 | 3. 2634 | 3. 2636 | 3. 2639 | 3. 2641 | 3. 2643 | 3. 2646 |
| | 30 | 40 | 3. 2648 | 3. 2651 | 3. 2653 | 3. 2655 | 3. 2658 | 3. 2660 | 3. 2662 | 3. 2665 | 3. 2667 | 3. 2669 |
| | 30 | 50 | 3. 2672 | 3. 2674 | 3. 2676 | 3. 2679 | 3. 2681 | 3. 2683 | 3. 2686 | 3. 2688 | 3. 2690 | 3. 2693 |
| 0 | 31 | 0 | 3. 2695 | 3. 2697 | 3. 2700 | 3. 2702 | 3. 2704 | 3. 2707 | 3. 2709 | 3. 2711 | 3. 2714 | 3. 2716 |
| | 31 | 10 | 3. 2718 | 3. 2721 | 3. 2723 | 3. 2725 | 3. 2728 | 3. 2730 | 3. 2732 | 3. 2735 | 3. 2737 | 3. 2739 |
| | 31 | 20 | 3. 2742 | 3. 2744 | 3. 2746 | 3. 2749 | 3. 2751 | 3. 2753 | 3. 2755 | 3. 2758 | 3. 2760 | 3. 2762 |
| | 31 | 30 | 3. 2765 | 3. 2767 | 3. 2769 | 3. 2772 | 3. 2774 | 3. 2776 | 3. 2778 | 3. 2781 | 3. 2783 | 3. 2785 |
| | 31 | 40 | 3. 2788 | 3. 2790 | 3. 2792 | 3. 2794 | 3. 2797 | 3. 2799 | 3. 2801 | 3. 2804 | 3. 2806 | 3. 2808 |
| | 31 | 50 | 3. 2810 | 3. 2813 | 3. 2815 | 3. 2817 | 3. 2819 | 3. 2822 | 3. 2824 | 3. 2826 | 3. 2828 | 3. 2831 |
| 0 | 32 | 0 | 3. 2833 | 3. 2835 | 3. 2838 | 3. 2840 | 3. 2842 | 3. 2844 | 3. 2847 | 3. 2849 | 3. 2851 | 3. 2853 |
| | 32 | 10 | 3. 2856 | 3. 2858 | 3. 2860 | 3. 2862 | 3. 2865 | 3. 2867 | 3. 2869 | 3. 2871 | 3. 2874 | 3. 2876 |
| | 32 | 20 | 3. 2878 | 3. 2880 | 3. 2882 | 3. 2885 | 3. 2887 | 3. 2889 | 3. 2891 | 3. 2894 | 3. 2896 | 3. 2898 |
| | 32 | 30 | 3. 2900 | 3. 2903 | 3. 2905 | 3. 2907 | 3. 2909 | 3. 2911 | 3. 2914 | 3. 2916 | 3. 2918 | 3. 2920 |
| | 32 | 40 | 3. 2923 | 3. 2925 | 3. 2927 | 3. 2929 | 3. 2931 | 3. 2934 | 3. 2936 | 3. 2938 | 3. 2940 | 3. 2942 |
| | 32 | 50 | 3. 2945 | 3. 2947 | 3. 2949 | 3. 2951 | 3. 2953 | 3. 2956 | 3. 2958 | 3. 2960 | 3. 2962 | 3. 2964 |
| 0 | 33 | 0 | 3. 2967 | 3. 2969 | 3. 2971 | 3. 2973 | 3. 2975 | 3. 2978 | 3. 2980 | 3. 2982 | 3. 2984 | 3. 2986 |
| | 33 | 10 | 3. 2989 | 3. 2991 | 3. 2993 | 3. 2995 | 3. 2997 | 3. 2999 | 3. 3002 | 3. 3004 | 3. 3006 | 3. 3008 |
| | 33 | 20 | 3. 3010 | 3. 3012 | 3. 3015 | 3. 3017 | 3. 3019 | 3. 3021 | 3. 3023 | 3. 3025 | 3. 3028 | 3. 3030 |
| | 33 | 30 | 3. 3032 | 3. 3034 | 3. 3036 | 3. 3038 | 3. 3041 | 3. 3043 | 3. 3045 | 3. 3047 | 3. 3049 | 3. 3051 |
| | 33 | 40 | 3. 3054 | 3. 3056 | 3. 3058 | 3. 3060 | 3. 3062 | 3. 3064 | 3. 3066 | 3. 3069 | 3. 3071 | 3. 3073 |
| | 33 | 50 | 3. 3075 | 3. 3077 | 3. 3079 | 3. 3081 | 3. 3084 | 3. 3086 | 3. 3088 | 3. 3090 | 3. 3092 | 3. 3094 |
| 0 | 34 | 0 | 3. 3096 | 3. 3098 | 3. 3101 | 3. 3103 | 3. 3105 | 3. 3107 | 3. 3109 | 3. 3111 | 3. 3113 | 3. 3115 |
| | 34 | 10 | 3. 3118 | 3. 3120 | 3. 3122 | 3. 3124 | 3. 3126 | 3. 3128 | 3. 3130 | 3. 3132 | 3. 3134 | 3. 3137 |
| | 34 | 20 | 3. 3139 | 3. 3141 | 3. 3143 | 3. 3145 | 3. 3147 | 3. 3149 | 3. 3151 | 3. 3153 | 3. 3156 | 3. 3158 |
| | 34 | 30 | 3. 3160 | 3. 3162 | 3. 3164 | 3. 3166 | 3. 3168 | 3. 3170 | 3. 3172 | 3. 3174 | 3. 3176 | 3. 3179 |
| | 34 | 40 | 3. 3181 | 3. 3183 | 3. 3185 | 3. 3187 | 3. 3189 | 3. 3191 | 3. 3193 | 3. 3195 | 3. 3197 | 3. 3199 |
| | 34 | 50 | 3. 3201 | 3. 3204 | 3. 3206 | 3. 3208 | 3. 3210 | 3. 3212 | 3. 3214 | 3. 3216 | 3. 3218 | 3. 3220 |
| 0 | 35 | 0 | 3. 3222 | 3. 3224 | 3. 3226 | 3. 3228 | 3. 3230 | 3. 3233 | 3. 3235 | 3. 3237 | 3. 3239 | 3. 3241 |
| | 35 | 10 | 3. 3243 | 3. 3245 | 3. 3247 | 3. 3249 | 3. 3251 | 3. 3253 | 3. 3255 | 3. 3257 | 3. 3259 | 3. 3261 |
| | 35 | 20 | 3. 3263 | 3. 3265 | 3. 3267 | 3. 3269 | 3. 3272 | 3. 3274 | 3. 3276 | 3. 3278 | 3. 3280 | 3. 3282 |
| | 35 | 30 | 3. 3284 | 3. 3286 | 3. 3288 | 3. 3290 | 3. 3292 | 3. 3294 | 3. 3296 | 3. 3298 | 3. 3300 | 3. 3302 |
| | 35 | 40 | 3. 3304 | 3. 3306 | 3. 3308 | 3. 3310 | 3. 3312 | 3. 3314 | 3. 3316 | 3. 3318 | 3. 3320 | 3. 3322 |
| | 35 | 50 | 3. 3324 | 3. 3326 | 3. 3328 | 3. 3330 | 3. 3332 | 3. 3334 | 3. 3336 | 3. 3339 | 3. 3341 | 3. 3343 |
| 0 | 36 | 0 | 3. 3345 | 3. 3347 | 3. 3349 | 3. 3351 | 3. 3353 | 3. 3355 | 3. 3357 | 3. 3359 | 3. 3361 | 3. 3363 |
| | 36 | 10 | 3. 3365 | 3. 3367 | 3. 3369 | 3. 3371 | 3. 3373 | 3. 3375 | 3. 3377 | 3. 3379 | 3. 3381 | 3. 3383 |
| | 36 | 20 | 3. 3385 | 3. 3387 | 3. 3389 | 3. 3391 | 3. 3393 | 3. 3395 | 3. 3397 | 3. 3398 | 3. 3400 | 3. 3402 |
| | 36 | 30 | 3. 3404 | 3. 3406 | 3. 3408 | 3. 3410 | 3. 3412 | 3. 3414 | 3. 3416 | 3. 3418 | 3. 3420 | 3. 3422 |
| | 36 | 40 | 3. 3424 | 3. 3426 | 3. 3428 | 3. 3430 | 3. 3432 | 3. 3434 | 3. 3436 | 3. 3438 | 3. 3440 | 3. 3442 |
| | 36 | 50 | 3. 3444 | 3. 3446 | 3. 3448 | 3. 3450 | 3. 3452 | 3. 3454 | 3. 3456 | 3. 3458 | 3. 3460 | 3. 3462 |
| 0 | 37 | 0 | 3. 3464 | 3. 3465 | 3. 3467 | 3. 3469 | 3. 3471 | 3. 3473 | 3. 3475 | 3. 3477 | 3. 3479 | 3. 3481 |
| | 37 | 10 | 3. 3483 | 3. 3485 | 3. 3487 | 3. 3489 | 3. 3491 | 3. 3493 | 3. 3495 | 3. 3497 | 3. 3499 | 3. 3501 |
| | 37 | 20 | 3. 3502 | 3. 3504 | 3. 3506 | 3. 3508 | 3. 3510 | 3. 3512 | 3. 3514 | 3. 3516 | 3. 3518 | 3. 3520 |
| | 37 | 30 | 3. 3522 | 3. 3524 | 3. 3526 | 3. 3528 | 3. 3530 | 3. 3531 | 3. 3533 | 3. 3535 | 3. 3537 | 3. 3539 |
| | 37 | 40 | 3. 3541 | 3. 3543 | 3. 3545 | 3. 3547 | 3. 3549 | 3. 3551 | 3. 3553 | 3. 3555 | 3. 3556 | 3. 3558 |
| | 37 | 50 | 3. 3560 | 3. 3562 | 3. 3564 | 3. 3566 | 3. 3568 | 3. 3570 | 3. 3572 | 3. 3574 | 3. 3576 | 3. 3577 |
| 0 | 38 | 0 | 3. 3579 | 3. 3581 | 3. 3583 | 3. 3585 | 3. 3587 | 3. 3589 | 3. 3591 | 3. 3593 | 3. 3595 | 3. 3596 |
| | 38 | 10 | 3. 3598 | 3. 3600 | 3. 3602 | 3. 3604 | 3. 3606 | 3. 3608 | 3. 3610 | 3. 3612 | 3. 3614 | 3. 3615 |
| | 38 | 20 | 3. 3617 | 3. 3619 | 3. 3621 | 3. 3623 | 3. 3625 | 3. 3627 | 3. 3629 | 3. 3630 | 3. 3632 | 3. 3634 |
| | 38 | 30 | 3. 3636 | 3. 3638 | 3. 3640 | 3. 3642 | 3. 3644 | 3. 3646 | 3. 3647 | 3. 3649 | 3. 3651 | 3. 3653 |
| | 38 | 40 | 3. 3655 | 3. 3657 | 3. 3659 | 3. 3660 | 3. 3662 | 3. 3664 | 3. 3666 | 3. 3668 | 3. 3670 | 3. 3672 |
| | 38 | 50 | 3. 3674 | 3. 3675 | 3. 3677 | 3. 3679 | 3. 3681 | 3. 3683 | 3. 3685 | 3. 3687 | 3. 3688 | 3. 3690 |
| 0 | 39 | 0 | 3. 3692 | 3. 3694 | 3. 3696 | 3. 3698 | 3. 3700 | 3. 3701 | 3. 3703 | 3. 3705 | 3. 3707 | 3. 3709 |
| | 39 | 10 | 3. 3711 | 3. 3713 | 3. 3714 | 3. 3716 | 3. 3718 | 3. 3720 | 3. 3722 | 3. 3724 | 3. 3725 | 3. 3727 |
| | 39 | 20 | 3. 3729 | 3. 3731 | 3. 3733 | 3. 3735 | 3. 3736 | 3. 3738 | 3. 3740 | 3. 3742 | 3. 3744 | 3. 3746 |
| | 39 | 30 | 3. 3747 | 3. 3749 | 3. 3751 | 3. 3753 | 3. 3755 | 3. 3757 | 3. 3758 | 3. 3760 | 3. 3762 | 3. 3764 |
| | 39 | 40 | 3. 3766 | 3. 3768 | 3. 3769 | 3. 3771 | 3. 3773 | 3. 3775 | 3. 3777 | 3. 3779 | 3. 3780 | 3. 3782 |
| | 39 | 50 | 3. 3784 | 3. 3786 | 3. 3788 | 3. 3789 | 3. 3791 | 3. 3793 | 3. 3795 | 3. 3797 | 3. 3798 | 3. 3800 |

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0ʰ | 40ᵐ | 0ˢ | 3.3802 | 3.3804 | 3.3806 | 3.3808 | 3.3809 | 3.3811 | 3.3813 | 3.3815 | 3.3817 | 3.3818 |
| | 40 | 10 | 3.3820 | 3.3822 | 3.3824 | 3.3826 | 3.3827 | 3.3829 | 3.3831 | 3.3833 | 3.3835 | 3.3836 |
| | 40 | 20 | 3.3838 | 3.3840 | 3.3842 | 3.3844 | 3.3845 | 3.3847 | 3.3849 | 3.3851 | 3.3852 | 3.3854 |
| | 40 | 30 | 3.3856 | 3.3858 | 3.3860 | 3.3861 | 3.3863 | 3.3865 | 3.3867 | 3.3869 | 3.3870 | 3.3872 |
| | 40 | 40 | 3.3874 | 3.3876 | 3.3877 | 3.3879 | 3.3881 | 3.3883 | 3.3885 | 3.3886 | 3.3888 | 3.3890 |
| | 40 | 50 | 3.3892 | 3.3893 | 3.3895 | 3.3897 | 3.3899 | 3.3901 | 3.3902 | 3.3904 | 3.3906 | 3.3908 |
| 0 | 41 | 0 | 3.3909 | 3.3911 | 3.3913 | 3.3915 | 3.3916 | 3.3918 | 3.3920 | 3.3922 | 3.3923 | 3.3925 |
| | 41 | 10 | 3.3927 | 3.3929 | 3.3930 | 3.3932 | 3.3934 | 3.3936 | 3.3938 | 3.3939 | 3.3941 | 3.3943 |
| | 41 | 20 | 3.3945 | 3.3946 | 3.3948 | 3.3950 | 3.3952 | 3.3953 | 3.3955 | 3.3957 | 3.3959 | 3.3960 |
| | 41 | 30 | 3.3962 | 3.3964 | 3.3965 | 3.3967 | 3.3969 | 3.3971 | 3.3972 | 3.3974 | 3.3976 | 3.3978 |
| | 41 | 40 | 3.3979 | 3.3981 | 3.3983 | 3.3985 | 3.3986 | 3.3988 | 3.3990 | 3.3992 | 3.3993 | 3.3995 |
| | 41 | 50 | 3.3997 | 3.3998 | 3.4000 | 3.4002 | 3.4004 | 3.4005 | 3.4007 | 3.4009 | 3.4011 | 3.4012 |
| 0 | 42 | 0 | 3.4014 | 3.4016 | 3.4017 | 3.4019 | 3.4021 | 3.4023 | 3.4024 | 3.4026 | 3.4028 | 3.4029 |
| | 42 | 10 | 3.4031 | 3.4033 | 3.4035 | 3.4036 | 3.4038 | 3.4040 | 3.4041 | 3.4043 | 3.4045 | 3.4047 |
| | 42 | 20 | 3.4048 | 3.4050 | 3.4052 | 3.4053 | 3.4055 | 3.4057 | 3.4059 | 3.4060 | 3.4062 | 3.4064 |
| | 42 | 30 | 3.4065 | 3.4067 | 3.4069 | 3.4071 | 3.4072 | 3.4074 | 3.4076 | 3.4077 | 3.4079 | 3.4081 |
| | 42 | 40 | 3.4082 | 3.4084 | 3.4086 | 3.4087 | 3.4089 | 3.4091 | 3.4093 | 3.4094 | 3.4096 | 3.4098 |
| | 42 | 50 | 3.4099 | 3.4101 | 3.4103 | 3.4104 | 3.4106 | 3.4108 | 3.4109 | 3.4111 | 3.4113 | 3.4115 |
| 0 | 43 | 0 | 3.4116 | 3.4118 | 3.4120 | 3.4121 | 3.4123 | 3.4125 | 3.4126 | 3.4128 | 3.4130 | 3.4131 |
| | 43 | 10 | 3.4133 | 3.4135 | 3.4136 | 3.4138 | 3.4140 | 3.4141 | 3.4143 | 3.4145 | 3.4146 | 3.4148 |
| | 43 | 20 | 3.4150 | 3.4151 | 3.4153 | 3.4155 | 3.4156 | 3.4158 | 3.4160 | 3.4161 | 3.4163 | 3.4165 |
| | 43 | 30 | 3.4166 | 3.4168 | 3.4170 | 3.4171 | 3.4173 | 3.4175 | 3.4176 | 3.4178 | 3.4180 | 3.4181 |
| | 43 | 40 | 3.4183 | 3.4185 | 3.4186 | 3.4188 | 3.4190 | 3.4191 | 3.4193 | 3.4195 | 3.4196 | 3.4198 |
| | 43 | 50 | 3.4200 | 3.4201 | 3.4203 | 3.4205 | 3.4206 | 3.4208 | 3.4209 | 3.4211 | 3.4213 | 3.4214 |
| 0 | 44 | 0 | 3.4216 | 3.4218 | 3.4219 | 3.4221 | 3.4223 | 3.4224 | 3.4226 | 3.4228 | 3.4229 | 3.4231 |
| | 44 | 10 | 3.4232 | 3.4234 | 3.4236 | 3.4237 | 3.4239 | 3.4241 | 3.4242 | 3.4244 | 3.4246 | 3.4247 |
| | 44 | 20 | 3.4249 | 3.4250 | 3.4252 | 3.4254 | 3.4255 | 3.4257 | 3.4259 | 3.4260 | 3.4262 | 3.4263 |
| | 44 | 30 | 3.4265 | 3.4267 | 3.4268 | 3.4270 | 3.4272 | 3.4273 | 3.4275 | 3.4276 | 3.4278 | 3.4280 |
| | 44 | 40 | 3.4281 | 3.4283 | 3.4285 | 3.4286 | 3.4288 | 3.4289 | 3.4291 | 3.4293 | 3.4294 | 3.4296 |
| | 44 | 50 | 3.4298 | 3.4299 | 3.4301 | 3.4302 | 3.4304 | 3.4306 | 3.4307 | 3.4309 | 3.4310 | 3.4312 |
| 0 | 45 | 0 | 3.4314 | 3.4315 | 3.4317 | 3.4318 | 3.4320 | 3.4322 | 3.4323 | 3.4325 | 3.4326 | 3.4328 |
| | 45 | 10 | 3.4330 | 3.4331 | 3.4333 | 3.4334 | 3.4336 | 3.4338 | 3.4339 | 3.4341 | 3.4342 | 3.4344 |
| | 45 | 20 | 3.4346 | 3.4347 | 3.4349 | 3.4350 | 3.4352 | 3.4354 | 3.4355 | 3.4357 | 3.4358 | 3.4360 |
| | 45 | 30 | 3.4362 | 3.4363 | 3.4365 | 3.4366 | 3.4368 | 3.4370 | 3.4371 | 3.4373 | 3.4374 | 3.4376 |
| | 45 | 40 | 3.4378 | 3.4379 | 3.4381 | 3.4382 | 3.4384 | 3.4385 | 3.4387 | 3.4389 | 3.4390 | 3.4392 |
| | 45 | 50 | 3.4393 | 3.4395 | 3.4396 | 3.4398 | 3.4400 | 3.4401 | 3.4403 | 3.4404 | 3.4406 | 3.4408 |
| 0 | 46 | 0 | 3.4409 | 3.4411 | 3.4412 | 3.4414 | 3.4415 | 3.4417 | 3.4419 | 3.4420 | 3.4422 | 3.4423 |
| | 46 | 10 | 3.4425 | 3.4426 | 3.4428 | 3.4429 | 3.4431 | 3.4433 | 3.4434 | 3.4436 | 3.4437 | 3.4439 |
| | 46 | 20 | 3.4440 | 3.4442 | 3.4444 | 3.4445 | 3.4447 | 3.4448 | 3.4450 | 3.4451 | 3.4453 | 3.4454 |
| | 46 | 30 | 3.4456 | 3.4458 | 3.4459 | 3.4461 | 3.4462 | 3.4464 | 3.4465 | 3.4467 | 3.4468 | 3.4470 |
| | 46 | 40 | 3.4472 | 3.4473 | 3.4475 | 3.4476 | 3.4478 | 3.4479 | 3.4481 | 3.4482 | 3.4484 | 3.4486 |
| | 46 | 50 | 3.4487 | 3.4489 | 3.4490 | 3.4492 | 3.4493 | 3.4495 | 3.4496 | 3.4498 | 3.4499 | 3.4501 |
| 0 | 47 | 0 | 3.4502 | 3.4504 | 3.4506 | 3.4507 | 3.4509 | 3.4510 | 3.4512 | 3.4513 | 3.4515 | 3.4516 |
| | 47 | 10 | 3.4518 | 3.4519 | 3.4521 | 3.4522 | 3.4524 | 3.4526 | 3.4527 | 3.4529 | 3.4530 | 3.4532 |
| | 47 | 20 | 3.4533 | 3.4535 | 3.4536 | 3.4538 | 3.4539 | 3.4541 | 3.4542 | 3.4544 | 3.4545 | 3.4547 |
| | 47 | 30 | 3.4548 | 3.4550 | 3.4551 | 3.4553 | 3.4555 | 3.4556 | 3.4558 | 3.4559 | 3.4561 | 3.4562 |
| | 47 | 40 | 3.4564 | 3.4565 | 3.4567 | 3.4568 | 3.4570 | 3.4571 | 3.4573 | 3.4574 | 3.4576 | 3.4577 |
| | 47 | 50 | 3.4579 | 3.4580 | 3.4582 | 3.4583 | 3.4585 | 3.4586 | 3.4588 | 3.4589 | 3.4591 | 3.4592 |
| 0 | 48 | 0 | 3.4594 | 3.4595 | 3.4597 | 3.4598 | 3.4600 | 3.4601 | 3.4603 | 3.4604 | 3.4606 | 3.4607 |
| | 48 | 10 | 3.4609 | 3.4610 | 3.4612 | 3.4613 | 3.4615 | 3.4616 | 3.4618 | 3.4619 | 3.4621 | 3.4622 |
| | 48 | 20 | 3.4624 | 3.4625 | 3.4627 | 3.4628 | 3.4630 | 3.4631 | 3.4633 | 3.4634 | 3.4636 | 3.4637 |
| | 48 | 30 | 3.4639 | 3.4640 | 3.4642 | 3.4643 | 3.4645 | 3.4646 | 3.4648 | 3.4649 | 3.4651 | 3.4652 |
| | 48 | 40 | 3.4654 | 3.4655 | 3.4657 | 3.4658 | 3.4660 | 3.4661 | 3.4663 | 3.4664 | 3.4666 | 3.4667 |
| | 48 | 50 | 3.4669 | 3.4670 | 3.4672 | 3.4673 | 3.4675 | 3.4676 | 3.4678 | 3.4679 | 3.4681 | 3.4682 |
| 0 | 49 | 0 | 3.4683 | 3.4685 | 3.4686 | 3.4688 | 3.4689 | 3.4691 | 3.4692 | 3.4694 | 3.4695 | 3.4697 |
| | 49 | 10 | 3.4698 | 3.4700 | 3.4701 | 3.4703 | 3.4704 | 3.4706 | 3.4707 | 3.4709 | 3.4710 | 3.4711 |
| | 49 | 20 | 3.4713 | 3.4714 | 3.4716 | 3.4717 | 3.4719 | 3.4720 | 3.4722 | 3.4723 | 3.4725 | 3.4726 |
| | 49 | 30 | 3.4728 | 3.4729 | 3.4730 | 3.4732 | 3.4733 | 3.4735 | 3.4736 | 3.4738 | 3.4739 | 3.4741 |
| | 49 | 40 | 3.4742 | 3.4744 | 3.4745 | 3.4747 | 3.4748 | 3.4749 | 3.4751 | 3.4752 | 3.4754 | 3.4755 |
| | 49 | 50 | 3.4757 | 3.4758 | 3.4760 | 3.4761 | 3.4763 | 3.4764 | 3.4765 | 3.4767 | 3.4768 | 3.4770 |

# APPENDIX V: TABLE IX.

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 0ʰ | 50ᵐ | 0ˢ | 3.4771 | 3.4773 | 3.4774 | 3.4776 | 3.4777 | 3.4778 | 3.4780 | 3.4781 | 3.4783 | 3.4784 |
| | 50 | 10 | 3.4786 | 3.4787 | 3.4789 | 3.4790 | 3.4791 | 3.4793 | 3.4794 | 3.4796 | 3.4797 | 3.4799 |
| | 50 | 20 | 3.4800 | 3.4802 | 3.4803 | 3.4804 | 3.4806 | 3.4807 | 3.4809 | 3.4810 | 3.4812 | 3.4813 |
| | 50 | 30 | 3.4814 | 3.4816 | 3.4817 | 3.4819 | 3.4820 | 3.4822 | 3.4823 | 3.4824 | 3.4826 | 3.4827 |
| | 50 | 40 | 3.4829 | 3.4830 | 3.4832 | 3.4833 | 3.4834 | 3.4836 | 3.4837 | 3.4839 | 3.4840 | 3.4842 |
| | 50 | 50 | 3.4843 | 3.4844 | 3.4846 | 3.4847 | 3.4849 | 3.4850 | 3.4852 | 3.4853 | 3.4854 | 3.4856 |
| 0 | 51 | 0 | 3.4857 | 3.4859 | 3.4860 | 3.4861 | 3.4863 | 3.4864 | 3.4866 | 3.4667 | 3.4869 | 3.4870 |
| | 51 | 10 | 3.4871 | 3.4873 | 3.4874 | 3.4876 | 3.4877 | 3.4878 | 3.4880 | 3.4881 | 3.4883 | 3.4884 |
| | 51 | 20 | 3.4886 | 3.4887 | 3.4888 | 3.4890 | 3.4891 | 3.4893 | 3.4894 | 3.4895 | 3.4897 | 3.4898 |
| | 51 | 30 | 3.4900 | 3.4901 | 3.4902 | 3.4904 | 3.4905 | 3.4907 | 3.4908 | 3.4909 | 3.4911 | 3.4912 |
| | 51 | 40 | 3.4914 | 3.4915 | 3.4916 | 3.4918 | 3.4919 | 3.4921 | 3.4922 | 3.4923 | 3.4925 | 3.4926 |
| | 51 | 50 | 3.4928 | 3.4929 | 3.4930 | 3.4932 | 3.4933 | 3.4935 | 3.4936 | 3.4937 | 3.4939 | 3.4940 |
| 0 | 52 | 0 | 3.4942 | 3.4943 | 3.4944 | 3.4946 | 3.4947 | 3.4949 | 3.4950 | 3.4951 | 3.4953 | 3.4954 |
| | 52 | 10 | 3.4955 | 3.4957 | 3.4958 | 3.4960 | 3.4961 | 3.4962 | 3.4964 | 3.4965 | 3.4967 | 3.4968 |
| | 52 | 20 | 3.4969 | 3.4971 | 3.4972 | 3.4973 | 3.4975 | 3.4976 | 3.4978 | 3.4979 | 3.4980 | 3.4982 |
| | 52 | 30 | 3.4983 | 3.4984 | 3.4986 | 3.4987 | 3.4989 | 3.4990 | 3.4991 | 3.4993 | 3.4994 | 3.4995 |
| | 52 | 40 | 3.4997 | 3.4998 | 3.5000 | 3.5001 | 3.5002 | 3.5004 | 3.5005 | 3.5006 | 3.5008 | 3.5009 |
| | 52 | 50 | 3.5011 | 3.5012 | 3.5013 | 3.5015 | 3.5016 | 3.5017 | 3.5019 | 3.5020 | 3.5022 | 3.5023 |
| 0 | 53 | 0 | 3.5024 | 3.5026 | 3.5027 | 3.5028 | 3.5030 | 3.5031 | 3.5032 | 3.5034 | 3.5035 | 3.5037 |
| | 53 | 10 | 3.5038 | 3.5039 | 3.5041 | 3.5042 | 3.5043 | 3.5045 | 3.5046 | 3.5047 | 3.5049 | 3.5050 |
| | 53 | 20 | 3.5051 | 3.5053 | 3.5054 | 3.5056 | 3.5057 | 3.5058 | 3.5060 | 3.5061 | 3.5062 | 3.5064 |
| | 53 | 30 | 3.5065 | 3.5066 | 3.5068 | 3.5069 | 3.5070 | 3.5072 | 3.5073 | 3.5075 | 3.5076 | 3.5077 |
| | 53 | 40 | 3.5079 | 3.5080 | 3.5081 | 3.5083 | 3.5084 | 3.5085 | 3.5087 | 3.5088 | 3.5089 | 3.5091 |
| | 53 | 50 | 3.5092 | 3.5093 | 3.5095 | 3.5096 | 3.5097 | 3.5099 | 3.5100 | 3.5101 | 3.5103 | 3.5104 |
| 0 | 54 | 0 | 3.5105 | 3.5107 | 3.5108 | 3.5109 | 3.5111 | 3.5112 | 3.5113 | 3.5115 | 5.5116 | 3.5117 |
| | 54 | 10 | 3.5119 | 3.5120 | 3.5122 | 3.5123 | 3.5124 | 3.5126 | 3.5127 | 3.5128 | 3.5130 | 3.5131 |
| | 54 | 20 | 3.5132 | 3.5134 | 3.5135 | 3.5136 | 3.5138 | 3.5139 | 3.5140 | 3.5141 | 3.5143 | 3.5144 |
| | 54 | 30 | 3.5145 | 3.5147 | 3.5148 | 3.5149 | 3.5151 | 3.5152 | 3.5153 | 3.5155 | 3.5156 | 3.5157 |
| | 54 | 40 | 3.5159 | 3.5160 | 3.5161 | 3.5163 | 3.5164 | 3.5165 | 3.5167 | 3.5168 | 3.5169 | 3.5171 |
| | 54 | 50 | 3.5172 | 3.5173 | 3.5175 | 3.5176 | 3.5177 | 3.5179 | 3.5180 | 3.5181 | 3.5183 | 3.5184 |
| 0 | 55 | 0 | 3.5185 | 3.5186 | 3.5188 | 3.5189 | 3.5190 | 3.5192 | 3.5193 | 3.5194 | 3.5196 | 3.5197 |
| | 55 | 10 | 3.5198 | 3.5200 | 3.5201 | 3.5202 | 3.5204 | 3.5205 | 3.5206 | 3.5207 | 3.5209 | 3.5210 |
| | 55 | 20 | 3.5211 | 3.5213 | 3.5214 | 3.5215 | 3.5217 | 3.5218 | 3.5219 | 3.5221 | 3.5222 | 3.5223 |
| | 55 | 30 | 3.5224 | 3.5226 | 3.5227 | 3.5228 | 3.5230 | 3.5231 | 3.5232 | 3.5234 | 3.5235 | 3.5236 |
| | 55 | 40 | 3.5237 | 3.5239 | 3.5240 | 3.5241 | 3.5243 | 3.5244 | 3.5245 | 3.5247 | 3.5248 | 3.5249 |
| | 55 | 50 | 3.5250 | 3.5252 | 3.5253 | 3.5254 | 3.5256 | 3.5257 | 3.5258 | 3.5260 | 3.5261 | 3.5262 |
| 0 | 56 | 0 | 3.5263 | 3.5265 | 3.5266 | 3.5267 | 3.5269 | 3.5270 | 3.5271 | 3.5272 | 3.5274 | 3.5275 |
| | 56 | 10 | 3.5276 | 3.5278 | 3.5279 | 3.5280 | 3.5281 | 3.5283 | 3.5284 | 3.5285 | 3.5287 | 3.5288 |
| | 56 | 20 | 3.5289 | 3.5290 | 3.5292 | 3.5293 | 3.5294 | 3.5296 | 3.5297 | 3.5298 | 3.5299 | 3.5301 |
| | 56 | 30 | 3.5302 | 3.5303 | 3.5305 | 3.5306 | 3.5307 | 3.5308 | 3.5310 | 3.5311 | 3.5312 | 3.5314 |
| | 56 | 40 | 3.5315 | 3.5316 | 3.5317 | 3.5319 | 3.5320 | 3.5321 | 3.5322 | 3.5324 | 3.5325 | 3.5326 |
| | 56 | 50 | 3.5328 | 3.5329 | 3.5330 | 3.5331 | 3.5333 | 3.5334 | 3.5335 | 3.5336 | 3.5338 | 3.5339 |
| 0 | 57 | 0 | 3.5340 | 3.5342 | 3.5343 | 3.5344 | 3.5345 | 3.5347 | 3.5348 | 3.5349 | 3.5350 | 3.5352 |
| | 57 | 10 | 3.5353 | 3.5354 | 3.5355 | 3.5357 | 3.5358 | 3.5359 | 3.5361 | 3.5362 | 3.5363 | 3.5364 |
| | 57 | 20 | 3.5366 | 3.5367 | 3.5368 | 3.5369 | 3.5371 | 3.5372 | 3.5373 | 3.5374 | 3.5376 | 3.5377 |
| | 57 | 30 | 3.5378 | 3.5379 | 3.5381 | 3.5382 | 3.5383 | 3.5384 | 3.5386 | 3.5387 | 3.5388 | 3.5390 |
| | 57 | 40 | 3.5391 | 3.5392 | 3.5393 | 3.5395 | 3.5396 | 3.5397 | 3.5398 | 3.5400 | 3.5401 | 3.5402 |
| | 57 | 50 | 3.5403 | 3.5405 | 3.5406 | 3.5407 | 3.5408 | 3.5410 | 3.5411 | 3.5412 | 3.5413 | 3.5415 |
| 0 | 58 | 0 | 3.5416 | 3.5417 | 3.5418 | 3.5420 | 3.5421 | 3.5422 | 3.5423 | 3.5425 | 3.5426 | 3.5427 |
| | 58 | 10 | 3.5428 | 3.5429 | 3.5431 | 3.5432 | 3.5433 | 3.5434 | 3.5436 | 3.5437 | 3.5438 | 3.5439 |
| | 58 | 20 | 3.5441 | 3.5442 | 3.5443 | 3.5444 | 3.5446 | 3.5447 | 3.5448 | 3.5449 | 3.5451 | 3.5452 |
| | 58 | 30 | 3.5453 | 3.5454 | 3.5456 | 3.5457 | 3.5458 | 3.5459 | 3.5460 | 3.5462 | 3.5463 | 3.5464 |
| | 58 | 40 | 3.5465 | 3.5467 | 3.5468 | 3.5469 | 3.5470 | 3.5472 | 3.5473 | 3.5474 | 3.5475 | 3.5477 |
| | 58 | 50 | 3.5478 | 3.5479 | 3.5480 | 3.5481 | 3.5483 | 3.5484 | 3.5485 | 3.5486 | 3.5488 | 3.5489 |
| 0 | 59 | 0 | 3.5490 | 3.5491 | 3.5492 | 3.5494 | 3.5495 | 3.5496 | 3.5497 | 3.5499 | 3.5500 | 3.5501 |
| | 59 | 10 | 3.5502 | 3.5504 | 3.5505 | 3.5506 | 3.5507 | 3.5508 | 3.5510 | 3.5511 | 3.5512 | 3.5513 |
| | 59 | 20 | 3.5514 | 3.5516 | 3.5517 | 3.5518 | 3.5519 | 3.5521 | 3.5522 | 3.5523 | 3.5524 | 3.5525 |
| | 59 | 30 | 3.5527 | 3.5528 | 3.5529 | 3.5530 | 3.5532 | 3.5533 | 3.5534 | 3.5535 | 3.5536 | 3.5538 |
| | 59 | 40 | 3.5539 | 3.5540 | 3.5541 | 3.5542 | 3.5544 | 3.5545 | 3.5546 | 3.5547 | 3.5549 | 3.5550 |
| | 59 | 50 | 3.5551 | 3.5552 | 3.5553 | 3.5555 | 3.5556 | 3.5557 | 3.5558 | 3.5559 | 3.5561 | 3.5562 |

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1ʰ 0ᵐ | 0ˢ | | 3.5563 | 3.5564 | 3.5565 | 3.5567 | 3.5568 | 3.5569 | 3.5570 | 3.5571 | 3.5573 | 3.5574 |
| 0 | 10 | | 3.5575 | 3.5576 | 3.5577 | 3.5579 | 3.5580 | 3.5581 | 3.5582 | 3.5583 | 3.5585 | 3.5586 |
| 0 | 20 | | 3.5587 | 3.5588 | 3.5589 | 3.5591 | 3.5592 | 3.5593 | 3.5594 | 3.5595 | 3.5597 | 3.5598 |
| 0 | 30 | | 3.5599 | 3.5600 | 3.5601 | 3.5603 | 3.5604 | 3.5605 | 3.5606 | 3.5607 | 3.5609 | 3.5610 |
| 0 | 40 | | 3.5611 | 3.5612 | 3.5613 | 3.5615 | 3.5616 | 3.5617 | 3.5618 | 3.5619 | 3.5621 | 3.5622 |
| 0 | 50 | | 3.5623 | 3.5624 | 3.5625 | 3.5626 | 3.5628 | 3.5629 | 3.5630 | 3.5631 | 3.5632 | 3.5634 |
| 1 | 1 | 0 | 3.5635 | 3.5636 | 3.5637 | 3.5638 | 3.5640 | 3.5641 | 3.5642 | 3.5643 | 3.5644 | 3.5645 |
| 1 | 10 | | 3.5647 | 3.5648 | 3.5649 | 3.5650 | 3.5651 | 3.5653 | 3.5654 | 3.5655 | 3.5656 | 3.5657 |
| 1 | 20 | | 3.5658 | 3.5660 | 3.5661 | 3.5662 | 3.5663 | 3.5664 | 3.5666 | 3.5667 | 3.5668 | 3.5669 |
| 1 | 30 | | 3.5670 | 3.5671 | 3.5673 | 3.5674 | 3.5675 | 3.5676 | 3.5677 | 3.5678 | 3.5680 | 3.5681 |
| 1 | 40 | | 3.5682 | 3.5683 | 3.5684 | 3.5686 | 3.5687 | 3.5688 | 3.5689 | 3.5690 | 3.5691 | 3.5693 |
| 1 | 50 | | 3.5694 | 3.5695 | 3.5696 | 3.5697 | 3.5698 | 3.5700 | 3.5701 | 3.5702 | 3.5703 | 3.5704 |
| 1 | 2 | 0 | 3.5705 | 3.5707 | 3.5708 | 3.5709 | 3.5710 | 3.5711 | 3.5712 | 3.5714 | 3.5715 | 3.5716 |
| 2 | 10 | | 3.5717 | 3.5718 | 3.5719 | 3.5721 | 3.5722 | 3.5723 | 3.5724 | 3.5725 | 3.5726 | 3.5728 |
| 2 | 20 | | 3.5729 | 3.5730 | 3.5731 | 3.5732 | 3.5733 | 3.5735 | 3.5736 | 3.5737 | 3.5738 | 3.5739 |
| 2 | 30 | | 3.5740 | 3.5741 | 3.5742 | 3.5744 | 3.5745 | 3.5746 | 3.5747 | 3.5748 | 3.5750 | 3.5751 |
| 2 | 40 | | 3.5752 | 3.5753 | 3.5754 | 3.5755 | 3.5756 | 3.5758 | 3.5759 | 3.5760 | 3.5761 | 3.5762 |
| 2 | 50 | | 3.5763 | 3.5765 | 3.5766 | 3.5767 | 3.5768 | 3.5769 | 3.5770 | 3.5771 | 3.5773 | 3.5774 |
| 1 | 3 | 0 | 3.5775 | 3.5776 | 3.5777 | 3.5778 | 3.5780 | 3.5781 | 3.5782 | 3.5783 | 3.5784 | 3.5785 |
| 3 | 10 | | 3.5786 | 3.5788 | 3.5789 | 3.5790 | 3.5791 | 3.5792 | 3.5793 | 3.5794 | 3.5796 | 3.5797 |
| 3 | 20 | | 3.5798 | 3.5799 | 3.5800 | 3.5801 | 3.5802 | 3.5804 | 3.5805 | 3.5806 | 3.5807 | 3.5808 |
| 3 | 30 | | 3.5809 | 3.5810 | 3.5812 | 3.5813 | 3.5814 | 3.5815 | 3.5816 | 3.5817 | 3.5818 | 3.5819 |
| 3 | 40 | | 3.5821 | 3.5822 | 3.5823 | 3.5824 | 3.5825 | 3.5826 | 3.5827 | 3.5829 | 3.5830 | 3.5831 |
| 3 | 50 | | 3.5832 | 3.5833 | 3.5834 | 3.5835 | 3.5837 | 3.5838 | 3.5839 | 3.5840 | 3.5841 | 3.5842 |
| 1 | 4 | 0 | 3.5843 | 3.5844 | 3.5846 | 3.5847 | 3.5848 | 3.5849 | 3.5850 | 3.5851 | 3.5852 | 3.5853 |
| 4 | 10 | | 3.5855 | 3.5856 | 3.5857 | 3.5858 | 3.5859 | 3.5860 | 3.5861 | 3.5862 | 3.5864 | 3.5865 |
| 4 | 20 | | 3.5866 | 3.5867 | 3.5868 | 3.5869 | 3.5870 | 3.5871 | 3.5873 | 3.5874 | 3.5875 | 3.5876 |
| 4 | 30 | | 3.5877 | 3.5878 | 3.5879 | 3.5880 | 3.5882 | 3.5883 | 3.5884 | 3.5885 | 3.5886 | 3.5887 |
| 4 | 40 | | 3.5888 | 3.5889 | 3.5891 | 3.5892 | 3.5893 | 3.5894 | 3.5895 | 3.5896 | 3.5897 | 3.5898 |
| 4 | 50 | | 3.5899 | 3.5901 | 3.5902 | 3.5903 | 3.5904 | 3.5905 | 3.5906 | 3.5907 | 3.5908 | 3.5910 |
| 1 | 5 | 0 | 3.5911 | 3.5912 | 3.5913 | 3.5914 | 3.5915 | 3.5916 | 3.5917 | 3.5918 | 3.5920 | 3.5921 |
| 5 | 10 | | 3.5922 | 3.5923 | 3.5924 | 3.5925 | 3.5926 | 3.5927 | 3.5928 | 3.5930 | 3.5931 | 3.5932 |
| 5 | 20 | | 3.5933 | 3.5934 | 3.5935 | 3.5936 | 3.5937 | 3.5938 | 3.5940 | 3.5941 | 3.5942 | 3.5943 |
| 5 | 30 | | 3.5944 | 3.5945 | 3.5946 | 3.5947 | 3.5948 | 3.5949 | 3.5951 | 3.5952 | 3.5953 | 3.5954 |
| 5 | 40 | | 3.5955 | 3.5956 | 3.5957 | 3.5958 | 3.5959 | 3.5960 | 3.5962 | 3.5963 | 3.5964 | 3.5965 |
| 5 | 50 | | 3.5966 | 3.5967 | 3.5968 | 3.5969 | 3.5970 | 3.5971 | 3.5973 | 3.5974 | 3.5975 | 3.5976 |
| 1 | 6 | 0 | 3.5977 | 3.5978 | 3.5979 | 3.5980 | 3.5981 | 3.5982 | 3.5984 | 3.5985 | 3.5986 | 3.5987 |
| 6 | 10 | | 3.5988 | 3.5989 | 3.5990 | 3.5991 | 3.5992 | 3.5993 | 3.5994 | 3.5996 | 3.5997 | 3.5998 |
| 6 | 20 | | 3.5999 | 3.6000 | 3.6001 | 3.6002 | 3.6003 | 3.6004 | 3.6005 | 3.6006 | 3.6008 | 3.6009 |
| 6 | 30 | | 3.6010 | 3.6011 | 3.6012 | 3.6013 | 3.6014 | 3.6015 | 3.6016 | 3.6017 | 3.6018 | 3.6020 |
| 6 | 40 | | 3.6021 | 3.6022 | 3.6023 | 3.6024 | 3.6025 | 3.6026 | 3.6027 | 3.6028 | 3.6029 | 3.6030 |
| 6 | 50 | | 3.6031 | 3.6033 | 3.6034 | 3.6035 | 3.6036 | 3.6037 | 3.6038 | 3.6039 | 3.6040 | 3.6041 |
| 1 | 7 | 0 | 3.6042 | 3.6043 | 3.6044 | 3.6046 | 3.6047 | 3.6048 | 3.6049 | 3.6050 | 3.6051 | 3.6052 |
| 7 | 10 | | 3.6053 | 3.6054 | 3.6055 | 3.6056 | 3.6057 | 3.6058 | 3.6060 | 3.6061 | 3.6062 | 3.6063 |
| 7 | 20 | | 3.6064 | 3.6065 | 3.6066 | 3.6067 | 3.6068 | 3.6069 | 3.6070 | 3.6071 | 3.6072 | 3.6073 |
| 7 | 30 | | 3.6075 | 3.6076 | 3.6077 | 3.6078 | 3.6079 | 3.6080 | 3.6081 | 3.6082 | 3.6083 | 3.6084 |
| 7 | 40 | | 3.6085 | 3.6086 | 3.6087 | 3.6088 | 3.6090 | 3.6091 | 3.6092 | 3.6093 | 3.6094 | 3.6095 |
| 7 | 50 | | 3.6096 | 3.6097 | 3.6098 | 3.6099 | 3.6100 | 3.6101 | 3.6102 | 3.6103 | 3.6104 | 3.6106 |
| 1 | 8 | 0 | 3.6107 | 3.6108 | 3.6109 | 3.6110 | 3.6111 | 3.6112 | 3.6113 | 3.6114 | 3.6115 | 3.6116 |
| 8 | 10 | | 3.6117 | 3.6118 | 3.6119 | 3.6120 | 3.6121 | 3.6123 | 3.6124 | 3.6125 | 3.6126 | 3.6127 |
| 8 | 20 | | 3.6128 | 3.6129 | 3.6130 | 3.6131 | 3.6132 | 3.6133 | 3.6134 | 3.6135 | 3.6136 | 3.6137 |
| 8 | 30 | | 3.6138 | 3.6139 | 3.6141 | 3.6142 | 3.6143 | 3.6144 | 3.6145 | 3.6146 | 3.6147 | 3.6148 |
| 8 | 40 | | 3.6149 | 3.6150 | 3.6151 | 3.6152 | 3.6153 | 3.6154 | 3.6155 | 3.6156 | 3.6157 | 3.6158 |
| 8 | 50 | | 3.6160 | 3.6161 | 3.6162 | 3.6163 | 3.6164 | 3.6165 | 3.6166 | 3.6167 | 3.6168 | 3.6169 |
| 1 | 9 | 0 | 3.6170 | 3.6171 | 3.6172 | 3.6173 | 3.6174 | 3.6175 | 3.6176 | 3.6177 | 3.6178 | 3.6179 |
| 9 | 10 | | 3.6180 | 3.6182 | 3.6183 | 3.6184 | 3.6185 | 3.6186 | 3.6187 | 3.6188 | 3.6189 | 3.6190 |
| 9 | 20 | | 3.6191 | 3.6192 | 3.6193 | 3.6194 | 3.6195 | 3.6196 | 3.6197 | 3.6198 | 3.6199 | 3.6200 |
| 9 | 30 | | 3.6201 | 3.6202 | 3.6203 | 3.6204 | 3.6206 | 3.6207 | 3.6208 | 3.6209 | 3.6210 | 3.6211 |
| 9 | 40 | | 3.6212 | 3.6213 | 3.6214 | 3.6215 | 3.6216 | 3.6217 | 3.6218 | 3.6219 | 3.6220 | 3.6221 |
| 9 | 50 | | 3.6222 | 3.6223 | 3.6224 | 3.6225 | 3.6226 | 3.6227 | 3.6228 | 3.6229 | 3.6230 | 3.6231 |

# APPENDIX V: TABLE IX.

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 1ʰ 10ᵐ | | 0ˢ | 3.6232 | 3.6234 | 3.6235 | 3.6236 | 3.6237 | 3.6238 | 3.6239 | 3.6240 | 3.6241 | 3.6242 |
| | 10 | 10 | 3.6243 | 3.6244 | 3.6245 | 3.6246 | 3.6247 | 3.6248 | 3.6249 | 3.6250 | 3.6251 | 3.6252 |
| | 10 | 20 | 3.6253 | 3.6254 | 3.6255 | 3.6256 | 3.6257 | 3.6258 | 3.6259 | 3.6260 | 3.6261 | 3.6262 |
| | 10 | 30 | 3.6263 | 3.6264 | 3.6265 | 3.6266 | 3.6268 | 3.6269 | 3.6270 | 3.6271 | 3.6272 | 3.6273 |
| | 10 | 40 | 3.6274 | 3.6275 | 3.6276 | 3.6277 | 3.6278 | 3.6279 | 3.6280 | 3.6281 | 3.6282 | 3.6283 |
| | 10 | 50 | 3.6284 | 3.6285 | 3.6286 | 3.6287 | 3.6288 | 3.6289 | 3.6290 | 3.6291 | 3.6292 | 3.6293 |
| 1 | 11 | 0 | 3.6294 | 3.6295 | 3.6296 | 3.6297 | 3.6298 | 3.6299 | 3.6300 | 3.6301 | 3.6302 | 3.6303 |
| | 11 | 10 | 3.6304 | 3.6305 | 3.6306 | 3.6307 | 3.6308 | 3.6309 | 3.6310 | 3.6311 | 3.6312 | 3.6313 |
| | 11 | 20 | 3.6314 | 3.6315 | 3.6316 | 3.6317 | 3.6318 | 3.6320 | 3.6321 | 3.6322 | 3.6323 | 3.6324 |
| | 11 | 30 | 3.6325 | 3.6326 | 3.6327 | 3.6328 | 3.6329 | 3.6330 | 3.6331 | 3.6332 | 3.6333 | 3.6334 |
| | 11 | 40 | 3.6335 | 3.6336 | 3.6337 | 3.6338 | 3.6339 | 3.6340 | 3.6341 | 3.6342 | 3.6343 | 3.6344 |
| | 11 | 50 | 3.6345 | 3.6346 | 3.6347 | 3.6348 | 3.6349 | 3.6350 | 3.6351 | 3.6352 | 3.6353 | 3.6354 |
| 1 | 12 | 0 | 3.6355 | 3.6356 | 3.6357 | 3.6358 | 3.6359 | 3.6360 | 3.6361 | 3.6362 | 3.6363 | 3.6364 |
| | 12 | 10 | 3.6365 | 3.6366 | 3.6367 | 3.6368 | 3.6369 | 3.6370 | 3.6371 | 3.6372 | 3.6373 | 3.6374 |
| | 12 | 20 | 3.6375 | 3.6376 | 3.6377 | 3.6378 | 3.6379 | 3.6380 | 3.6381 | 3.6382 | 3.6383 | 3.6384 |
| | 12 | 30 | 3.6385 | 3.6386 | 3.6387 | 3.6388 | 3.6389 | 3.6390 | 3.6391 | 3.6392 | 3.6393 | 3.6394 |
| | 12 | 40 | 3.6395 | 3.6396 | 3.6397 | 3.6398 | 3.6399 | 3.6400 | 3.6401 | 3.6402 | 3.6403 | 3.6404 |
| | 12 | 50 | 3.6405 | 3.6406 | 3.6407 | 3.6408 | 3.6409 | 3.6410 | 3.6411 | 3.6412 | 3.6413 | 3.6414 |
| 1 | 13 | 0 | 3.6415 | 3.6416 | 3.6417 | 3.6418 | 3.6419 | 3.6420 | 3.6421 | 3.6422 | 3.6423 | 3.6424 |
| | 13 | 10 | 3.6425 | 3.6426 | 3.6427 | 3.6428 | 3.6429 | 3.6430 | 3.6431 | 3.6432 | 3.6433 | 3.6434 |
| | 13 | 20 | 3.6435 | 3.6436 | 3.6437 | 3.6437 | 3.6438 | 3.6439 | 3.6440 | 3.6441 | 3.6442 | 3.6443 |
| | 13 | 30 | 3.6444 | 3.6445 | 3.6446 | 3.6447 | 3.6448 | 3.6449 | 3.6450 | 3.6451 | 3.6452 | 3.6453 |
| | 13 | 40 | 3.6454 | 3.6455 | 3.6456 | 3.6457 | 3.6458 | 3.6459 | 3.6460 | 3.6461 | 3.6462 | 3.6463 |
| | 13 | 50 | 3.6464 | 3.6465 | 3.6466 | 3.6467 | 3.6468 | 3.6469 | 3.6470 | 3.6471 | 3.6472 | 3.6473 |
| 1 | 14 | 0 | 3.6474 | 3.6475 | 3.6476 | 3.6477 | 3.6478 | 3.6479 | 3.6480 | 3.6481 | 3.6482 | 3.6483 |
| | 14 | 10 | 3.6484 | 3.6485 | 3.6486 | 3.6487 | 3.6488 | 3.6488 | 3.6489 | 3.6490 | 3.6491 | 3.6492 |
| | 14 | 20 | 3.6493 | 3.6494 | 3.6495 | 3.6496 | 3.6497 | 3.6498 | 3.6499 | 3.6500 | 3.6501 | 3.6502 |
| | 14 | 30 | 3.6503 | 3.6504 | 3.6505 | 3.6506 | 3.6507 | 3.6508 | 3.6509 | 3.6510 | 3.6511 | 3.6512 |
| | 14 | 40 | 3.6513 | 3.6514 | 3.6515 | 3.6516 | 3.6517 | 3.6518 | 3.6519 | 3.6520 | 3.6521 | 3.6521 |
| | 14 | 50 | 3.6522 | 3.6523 | 3.6524 | 3.6525 | 3.6526 | 3.6527 | 3.6528 | 3.6529 | 3.6530 | 3.6531 |
| 1 | 15 | 0 | 3.6532 | 3.6533 | 3.6534 | 3.6535 | 3.6536 | 3.6537 | 3.6538 | 3.6539 | 3.6540 | 3.6541 |
| | 15 | 10 | 3.6542 | 3.6543 | 3.6544 | 3.6545 | 3.6546 | 3.6547 | 3.6548 | 3.6549 | 3.6549 | 3.6550 |
| | 15 | 20 | 3.6551 | 3.6552 | 3.6553 | 3.6554 | 3.6555 | 3.6556 | 3.6557 | 3.6558 | 3.6559 | 3.6560 |
| | 15 | 30 | 3.6561 | 3.6562 | 3.6563 | 3.6564 | 3.6565 | 3.6566 | 3.6567 | 3.6568 | 3.6569 | 3.6570 |
| | 15 | 40 | 3.6571 | 3.6572 | 3.6572 | 3.6573 | 3.6574 | 3.6575 | 3.6576 | 3.6577 | 3.6578 | 3.6579 |
| | 15 | 50 | 3.6580 | 3.6581 | 3.6582 | 3.6583 | 3.6584 | 3.6585 | 3.6586 | 3.6587 | 3.6588 | 3.6589 |
| 1 | 16 | 0 | 3.6590 | 3.6591 | 3.6592 | 3.6593 | 3.6593 | 3.6594 | 3.6595 | 3.6596 | 3.6597 | 3.6598 |
| | 16 | 10 | 3.6599 | 3.6600 | 3.6601 | 3.6602 | 3.6603 | 3.6604 | 3.6605 | 3.6606 | 3.6607 | 3.6608 |
| | 16 | 20 | 3.6609 | 3.6610 | 3.6611 | 3.6611 | 3.6612 | 3.6613 | 3.6614 | 3.6615 | 3.6616 | 3.6617 |
| | 16 | 30 | 3.6618 | 3.6619 | 3.6620 | 3.6621 | 3.6622 | 3.6623 | 3.6624 | 3.6625 | 3.6626 | 3.6627 |
| | 16 | 40 | 3.6628 | 3.6629 | 3.6629 | 3.6630 | 3.6631 | 3.6632 | 3.6633 | 3.6634 | 3.6635 | 3.6636 |
| | 16 | 50 | 3.6637 | 3.6638 | 3.6639 | 3.6640 | 3.6641 | 3.6642 | 3.6643 | 3.6644 | 3.6645 | 3.6645 |
| 1 | 17 | 0 | 3.6646 | 3.6647 | 3.6648 | 3.6649 | 3.6650 | 3.6651 | 3.6652 | 3.6653 | 3.6654 | 3.6655 |
| | 17 | 10 | 3.6656 | 3.6657 | 3.6658 | 3.6659 | 3.6660 | 3.6660 | 3.6661 | 3.6662 | 3.6663 | 3.6664 |
| | 17 | 20 | 3.6665 | 3.6666 | 3.6667 | 3.6668 | 3.6669 | 3.6670 | 3.6671 | 3.6672 | 3.6673 | 3.6674 |
| | 17 | 30 | 3.6675 | 3.6675 | 3.6676 | 3.6677 | 3.6678 | 3.6679 | 3.6680 | 3.6681 | 3.6682 | 3.6683 |
| | 17 | 40 | 3.6684 | 3.6685 | 3.6686 | 3.6687 | 3.6688 | 3.6689 | 3.6689 | 3.6690 | 3.6691 | 3.6692 |
| | 17 | 50 | 3.6693 | 3.6694 | 3.6695 | 3.6696 | 3.6697 | 3.6698 | 3.6699 | 3.6700 | 3.6701 | 3.6702 |
| 1 | 18 | 0 | 3.6702 | 3.6703 | 3.6704 | 3.6705 | 3.6706 | 3.6707 | 3.6708 | 3.6709 | 3.6710 | 3.6711 |
| | 18 | 10 | 3.6712 | 3.6713 | 3.6714 | 3.6715 | 3.6715 | 3.6716 | 3.6717 | 3.6718 | 3.6719 | 3.6720 |
| | 18 | 20 | 3.6721 | 3.6722 | 3.6723 | 3.6724 | 3.6725 | 3.6726 | 3.6727 | 3.6727 | 3.6728 | 3.6729 |
| | 18 | 30 | 3.6730 | 3.6731 | 3.6732 | 3.6733 | 3.6734 | 3.6735 | 3.6736 | 3.6737 | 3.6738 | 3.6738 |
| | 18 | 40 | 3.6739 | 3.6740 | 3.6741 | 3.6742 | 3.6743 | 3.6744 | 3.6745 | 3.6746 | 3.6747 | 3.6748 |
| | 18 | 50 | 3.6749 | 3.6750 | 3.6750 | 3.6751 | 3.6752 | 3.6753 | 3.6754 | 3.6755 | 3.6756 | 3.6757 |
| 1 | 19 | 0 | 3.6758 | 3.6759 | 3.6760 | 3.6761 | 3.6761 | 3.6762 | 3.6763 | 3.6764 | 3.6765 | 3.6766 |
| | 19 | 10 | 3.6767 | 3.6768 | 3.6769 | 3.6770 | 3.6771 | 3.6772 | 3.6772 | 3.6773 | 3.6774 | 3.6775 |
| | 19 | 20 | 3.6776 | 3.6777 | 3.6778 | 3.6779 | 3.6780 | 3.6781 | 3.6782 | 3.6782 | 3.6783 | 3.6784 |
| | 19 | 30 | 3.6785 | 3.6786 | 3.6787 | 3.6788 | 3.6789 | 3.6790 | 3.6791 | 3.6792 | 3.6792 | 3.6793 |
| | 19 | 40 | 3.6794 | 3.6795 | 3.6796 | 3.6797 | 3.6798 | 3.6799 | 3.6800 | 3.6801 | 3.6802 | 3.6802 |
| | 19 | 50 | 3.6803 | 3.6804 | 3.6805 | 3.6806 | 3.6807 | 3.6808 | 3.6809 | 3.6810 | 3.6811 | 3.6812 |

# APPENDIX V: TABLE IX.

### Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1ʰ | 20ᵐ | 0ˢ | 3.6812 | 3.6813 | 3.6814 | 3.6815 | 3.6816 | 3.6817 | 3.6818 | 3.6819 | 3.6820 | 3.6821 |
| | 20 | 10 | 3.6821 | 3.6822 | 3.6823 | 3.6824 | 3.6825 | 3.6826 | 3.6827 | 3.6828 | 3.6829 | 3.6830 |
| | 20 | 20 | 3.6830 | 3.6831 | 3.6832 | 3.6833 | 3.6834 | 3.6835 | 3.6836 | 3.6837 | 3.6838 | 3.6839 |
| | 20 | 30 | 3.6839 | 3.6840 | 3.6841 | 3.6842 | 3.6843 | 3.6844 | 3.6845 | 3.6846 | 3.6847 | 3.6848 |
| | 20 | 40 | 3.6848 | 3.6849 | 3.6850 | 3.6851 | 3.6852 | 3.6853 | 3.6854 | 3.6855 | 3.6856 | 3.6857 |
| | 20 | 50 | 3.6857 | 3.6858 | 3.6859 | 3.6860 | 3.6861 | 3.6862 | 3.6863 | 3.6864 | 3.6865 | 3.6865 |
| 1 | 21 | 0 | 3.6866 | 3.6867 | 3.6868 | 3.6869 | 3.6870 | 3.6871 | 3.6872 | 3.6873 | 3.6874 | 3.6874 |
| | 21 | 10 | 3.6875 | 3.6876 | 3.6877 | 3.6878 | 3.6879 | 3.6880 | 3.6881 | 3.6882 | 3.6882 | 3.6883 |
| | 21 | 20 | 3.6884 | 3.6885 | 3.6886 | 3.6887 | 3.6888 | 3.6889 | 3.6890 | 3.6890 | 3.6891 | 3.6892 |
| | 21 | 30 | 3.6893 | 3.6894 | 3.6895 | 3.6896 | 3.6897 | 3.6898 | 3.6898 | 3.6899 | 3.6900 | 3.6901 |
| | 21 | 40 | 3.6902 | 3.6903 | 3.6904 | 3.6905 | 3.6906 | 3.6906 | 3.6907 | 3.6908 | 3.6909 | 3.6910 |
| | 21 | 50 | 3.6911 | 3.6912 | 3.6913 | 3.6913 | 3.6914 | 3.6915 | 3.6916 | 3.6917 | 3.6918 | 3.6919 |
| 1 | 22 | 0 | 3.6920 | 3.6921 | 3.6921 | 3.6922 | 3.6923 | 3.6924 | 3.6925 | 3.6926 | 3.6927 | 3.6928 |
| | 22 | 10 | 3.6928 | 3.6929 | 3.6930 | 3.6931 | 3.6932 | 3.6933 | 3.6934 | 3.6935 | 3.6936 | 3.6936 |
| | 22 | 20 | 3.6937 | 3.6938 | 3.6939 | 3.6940 | 3.6941 | 3.6942 | 3.6943 | 3.6943 | 3.6944 | 3.6945 |
| | 22 | 30 | 3.6946 | 3.6947 | 3.6948 | 3.6949 | 3.6950 | 3.6950 | 3.6951 | 3.6952 | 3.6953 | 3.6954 |
| | 22 | 40 | 3.6955 | 3.6956 | 3.6957 | 3.6957 | 3.6958 | 3.6959 | 3.6960 | 3.6961 | 3.3962 | 3.6963 |
| | 22 | 50 | 3.6964 | 3.6964 | 3.6965 | 3.6966 | 3.6967 | 3.6968 | 3.6969 | 3.6970 | 3.6971 | 3.6971 |
| 1 | 23 | 0 | 3.6972 | 3.6973 | 3.6974 | 3.6975 | 3.6976 | 3.6977 | 3.6978 | 3.6978 | 3.6979 | 3.6980 |
| | 23 | 10 | 3.6981 | 3.6982 | 3.6983 | 3.6984 | 3.6984 | 3.6985 | 3.6986 | 3.6987 | 3.6988 | 3.6989 |
| | 23 | 20 | 3.6990 | 3.6991 | 3.6991 | 3.6992 | 3.6993 | 3.6994 | 3.6995 | 3.6996 | 3.6997 | 3.6998 |
| | 23 | 30 | 3.6998 | 3.6999 | 3.7000 | 3.7001 | 3.7002 | 3.7003 | 3.7004 | 3.7004 | 3.7005 | 3.7006 |
| | 23 | 40 | 3.7007 | 3.7008 | 3.7009 | 3.7010 | 3.7010 | 3.7011 | 3.7012 | 3.7013 | 3.7014 | 3.7015 |
| | 23 | 50 | 3.7016 | 3.7017 | 3.7017 | 3.7018 | 3.7019 | 3.7020 | 3.7021 | 3.7022 | 3.7023 | 3.7023 |
| 1 | 24 | 0 | 3.7024 | 3.7025 | 3.7026 | 3.7027 | 3.7028 | 3.7029 | 3.7029 | 3.7030 | 3.7031 | 3.7032 |
| | 24 | 10 | 3.7033 | 3.7034 | 3.7035 | 3.7035 | 3.7036 | 3.7037 | 3.7038 | 3.7039 | 3.7040 | 3.7041 |
| | 24 | 20 | 3.7042 | 3.7042 | 3.7043 | 3.7044 | 3.7045 | 3.7046 | 3.7047 | 3.7048 | 3.7048 | 3.7049 |
| | 24 | 30 | 3.7050 | 3.7051 | 3.7052 | 3.7053 | 3.7054 | 3.7054 | 3.7055 | 3.7056 | 3.7057 | 3.7058 |
| | 24 | 40 | 3.7059 | 3.7060 | 3.7060 | 3.7061 | 3.7062 | 3.7063 | 3.7064 | 3.7065 | 3.7065 | 3.7066 |
| | 24 | 50 | 3.7067 | 3.7068 | 3.7069 | 3.7070 | 3.7071 | 3.7071 | 3.7072 | 3.7073 | 3.7074 | 3.7075 |
| 1 | 25 | 0 | 3.7076 | 3.7077 | 3.7077 | 3.7078 | 3.7079 | 3.7080 | 3.7081 | 3.7082 | 3.7083 | 3.7083 |
| | 25 | 10 | 3.7084 | 3.7085 | 3.7086 | 3.7087 | 3.7088 | 3.7088 | 3.7089 | 3.7090 | 3.7091 | 3.7092 |
| | 25 | 20 | 3.7093 | 3.7094 | 3.7094 | 3.7095 | 3.7096 | 3.7097 | 3.7098 | 3.7099 | 3.7099 | 3.7100 |
| | 25 | 30 | 3.7101 | 3.7102 | 3.7103 | 3.7104 | 3.7105 | 3.7105 | 3.7106 | 3.7107 | 3.7108 | 3.7109 |
| | 25 | 40 | 3.7110 | 3.7110 | 3.7111 | 3.7112 | 3.7113 | 2.7114 | 3.7115 | 3.7116 | 3.7116 | 3.7117 |
| | 25 | 50 | 3.7118 | 3.7119 | 3.7120 | 3.7121 | 3.7121 | 3.7122 | 3.7123 | 3.7124 | 3.7125 | 3.7126 |
| 1 | 26 | 0 | 3.7126 | 3.7127 | 3.7128 | 3.7129 | 3.7130 | 3.7131 | 3.7132 | 3.7132 | 3.7133 | 3.7134 |
| | 26 | 10 | 3.7135 | 3.7136 | 3.7137 | 3.7137 | 3.7138 | 3.7139 | 3.7140 | 3.7141 | 3.7142 | 3.7142 |
| | 26 | 20 | 3.7143 | 3.7144 | 3.7145 | 3.7146 | 3.7147 | 3.7147 | 3.7148 | 3.7149 | 3.7150 | 3.7151 |
| | 26 | 30 | 3.7152 | 3.7153 | 3.7153 | 3.7154 | 3.7155 | 3.7156 | 3.7157 | 3.7158 | 3.7159 | 3.7159 |
| | 26 | 40 | 3.7160 | 3.7161 | 3.7162 | 3.7163 | 3.7163 | 3.7164 | 3.7165 | 3.7166 | 3.7167 | 3.7168 |
| | 26 | 50 | 3.7168 | 3.7169 | 3.7170 | 3.7171 | 3.7172 | 3.7173 | 3.7173 | 3.7174 | 3.7175 | 3.7176 |
| 1 | 27 | 0 | 3.7177 | 3.7178 | 3.7178 | 3.7179 | 3.7180 | 3.7181 | 3.7182 | 3.7183 | 3.7183 | 3.7184 |
| | 27 | 10 | 3.7185 | 3.7186 | 3.7187 | 3.7188 | 3.7188 | 3.7189 | 3.7190 | 3.7191 | 3.7192 | 3.7192 |
| | 27 | 20 | 3.7193 | 3.7194 | 3.7195 | 3.7196 | 3.7197 | 3.7197 | 3.7198 | 3.7199 | 3.7200 | 3.7201 |
| | 27 | 30 | 3.7202 | 3.7202 | 3.7203 | 3.7204 | 3.7205 | 3.7206 | 3.7207 | 3.7207 | 3.7208 | 3.7209 |
| | 27 | 40 | 3.7210 | 3.7211 | 3.7212 | 3.7212 | 3.7213 | 3.7214 | 3.7215 | 3.7216 | 3.7216 | 3.7217 |
| | 27 | 50 | 3.7218 | 3.7219 | 3.7220 | 3.7221 | 3.7221 | 3.7222 | 3.7223 | 3.7224 | 3.7225 | 3.7226 |
| 1 | 28 | 0 | 3.7226 | 3.7227 | 3.7228 | 3.7229 | 3.7230 | 3.7230 | 3.7231 | 3.7232 | 3.7233 | 3.7234 |
| | 28 | 10 | 3.7235 | 3.7235 | 3.7236 | 3.7237 | 3.7238 | 3.7239 | 3.7239 | 3.7240 | 3.7241 | 3.7242 |
| | 28 | 20 | 3.7243 | 3.7244 | 3.7244 | 3.7245 | 3.7246 | 3.7247 | 3.7248 | 3.7248 | 3.7249 | 3.7250 |
| | 28 | 30 | 3.7251 | 3.7252 | 3.7253 | 3.7253 | 3.7254 | 3.7255 | 3.7256 | 3.7257 | 3.7257 | 3.7258 |
| | 28 | 40 | 3.7259 | 3.7260 | 3.7261 | 3.7262 | 3.7262 | 3.7263 | 3.7264 | 3.7265 | 3.7266 | 3.7266 |
| | 28 | 50 | 3.7267 | 3.7268 | 3.7269 | 3.7270 | 3.7271 | 3.7271 | 3.7272 | 3.7273 | 3.7274 | 3.7275 |
| 1 | 29 | 0 | 3.7275 | 3.7276 | 3.7277 | 3.7278 | 3.7279 | 3.7279 | 3.7280 | 3.7281 | 3.7282 | 3.7283 |
| | 29 | 10 | 3.7284 | 3.7284 | 3.7285 | 3.7286 | 3.7287 | 3.7288 | 3.7288 | 3.7289 | 3.7290 | 3.7291 |
| | 29 | 20 | 3.7292 | 3.7292 | 3.7293 | 3.7294 | 3.7295 | 3.7296 | 3.7297 | 3.7297 | 3.7298 | 3.7299 |
| | 29 | 30 | 3.7300 | 3.7301 | 3.7301 | 3.7302 | 3.7303 | 3.7304 | 3.7305 | 3.7305 | 3.7306 | 3.7307 |
| | 29 | 40 | 3.7308 | 3.7309 | 3.7309 | 3.7310 | 3.7311 | 3.7312 | 3.7313 | 3.7313 | 3.7314 | 3.7315 |
| | 29 | 50 | 3.7316 | 3.7317 | 3.7317 | 3.7318 | 3.7319 | 3.7320 | 3.7321 | 3.7322 | 3.7322 | 3.7323 |

# APPENDIX V: TABLE IX.

### Logarithms of Small Arcs in Space or Time.

| Arc. | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ ″ | | | | | | | | | | |
| 1ʰ 30ᵐ 0ˢ | 3.7324 | 3.7325 | 3.7326 | 3.7326 | 3.7327 | 3.7328 | 3.7329 | 3.7330 | 3.7330 | 3.7331 |
| 30 10 | 3.7332 | 3.7333 | 3.7334 | 3.7334 | 3.7335 | 3.7336 | 3.7337 | 3.7338 | 3.7338 | 3.7339 |
| 30 20 | 3.7340 | 3.7341 | 3.7342 | 3.7342 | 3.7343 | 3.7344 | 3.7345 | 3.7346 | 3.7346 | 3.7347 |
| 30 30 | 3.7348 | 3.7349 | 3.7350 | 3.7350 | 3.7351 | 3.7352 | 3.7353 | 3.7354 | 3.7354 | 3.7355 |
| 30 40 | 3.7356 | 3.7357 | 3.7358 | 3.7358 | 3.7359 | 3.7360 | 3.7361 | 3.7362 | 3.7362 | 3.7363 |
| 30 50 | 3.7364 | 3.7365 | 3.7366 | 3.7366 | 3.7367 | 3.7368 | 3.7369 | 3.7370 | 3.7370 | 3.7371 |
| 1 31 0 | 3.7372 | 3.7373 | 3.7374 | 3.7374 | 3.7375 | 3.7376 | 3.7377 | 3.7377 | 3.7378 | 3.7379 |
| 31 10 | 3.7380 | 3.7381 | 3.7381 | 3.7382 | 3.7383 | 3.7384 | 3.7385 | 3.7385 | 3.7386 | 3.7387 |
| 31 20 | 3.7388 | 3.7389 | 3.7389 | 3.7390 | 3.7391 | 3.7392 | 3.7393 | 3.7393 | 3.7394 | 3.7395 |
| 31 30 | 3.7396 | 3.7397 | 3.7397 | 3.7398 | 3.7399 | 3.7400 | 3.7400 | 3.7401 | 3.7402 | 3.7403 |
| 31 40 | 3.7404 | 3.7404 | 3.7405 | 3.7406 | 3.7407 | 3.7408 | 3.7408 | 3.7409 | 3.7410 | 3.7411 |
| 31 50 | 3.7412 | 3.7412 | 3.7413 | 3.7414 | 3.7415 | 3.7415 | 3.7416 | 3.7417 | 3.7418 | 3.7419 |
| 1 32 0 | 3.7419 | 3.7420 | 3.7421 | 3.7422 | 3.7423 | 3.7423 | 3.7424 | 3.7425 | 3.7426 | 3.7426 |
| 32 10 | 3.7427 | 3.7428 | 3.7429 | 3.7430 | 3.7430 | 3.7431 | 3.7432 | 3.7433 | 3.7434 | 3.7434 |
| 32 20 | 3.7435 | 3.7436 | 3.7437 | 3.7437 | 3.7438 | 3.7439 | 3.7440 | 3.7441 | 3.7441 | 3.7442 |
| 32 30 | 3.7443 | 3.7444 | 3.7444 | 3.7445 | 3.7446 | 3.7447 | 3.7448 | 3.7448 | 3.7449 | 3.7450 |
| 32 40 | 3.7451 | 3.7452 | 3.7452 | 3.7453 | 3.7454 | 3.7455 | 3.7455 | 3.7456 | 3.7457 | 3.7458 |
| 32 50 | 3.7459 | 3.7459 | 3.7460 | 3.7461 | 3.7462 | 3.7462 | 3.7463 | 3.7464 | 3.7465 | 3.7466 |
| 1 33 0 | 3.7466 | 3.7467 | 3.7468 | 3.7469 | 3.7469 | 3.7470 | 3.7471 | 3.7472 | 3.7473 | 3.7473 |
| 33 10 | 3.7474 | 3.7475 | 3.7476 | 3.7476 | 3.7477 | 3.7478 | 3.7479 | 3.7480 | 3.7480 | 3.7481 |
| 33 20 | 3.7482 | 3.7483 | 3.7483 | 3.7484 | 3.7485 | 3.7486 | 3.7487 | 3.7487 | 3.7488 | 3.7489 |
| 33 30 | 3.7490 | 3.7490 | 3.7491 | 3.7492 | 3.7493 | 3.7493 | 3.7494 | 3.7495 | 3.7496 | 3.7497 |
| 33 40 | 3.7497 | 3.7498 | 3.7499 | 3.7500 | 3.7500 | 3.7501 | 3.7502 | 3.7503 | 3.7504 | 3.7504 |
| 33 50 | 3.7505 | 3.7506 | 3.7507 | 3.7507 | 3.7508 | 3.7509 | 3.7510 | 3.7510 | 3.7511 | 3.7512 |
| 1 34 0 | 3.7513 | 3.7514 | 3.7514 | 3.7515 | 3.7516 | 3.7517 | 3.7517 | 3.7518 | 3.7519 | 3.7520 |
| 34 10 | 3.7520 | 3.7521 | 3.7522 | 3.7523 | 3.7524 | 3.7524 | 3.7525 | 3.7526 | 3.7527 | 3.7527 |
| 34 20 | 3.7528 | 3.7529 | 3.7530 | 3.7530 | 3.7531 | 3.7532 | 3.7533 | 3.7534 | 3.7534 | 3.7535 |
| 34 30 | 3.7536 | 3.7537 | 3.7537 | 3.7538 | 3.7539 | 3.7540 | 3.7540 | 3.7541 | 3.7542 | 3.7543 |
| 34 40 | 3.7543 | 3.7544 | 3.7545 | 3.7546 | 3.7547 | 3.7547 | 3.7548 | 3.7549 | 3.7550 | 3.7550 |
| 34 50 | 3.7551 | 3.7552 | 3.7553 | 3.7553 | 3.7554 | 3.7555 | 3.7556 | 3.7556 | 3.7557 | 3.7558 |
| 1 35 0 | 3.7559 | 3.7560 | 3.7560 | 3.7561 | 3.7562 | 3.7563 | 3.7563 | 3.7564 | 3.7565 | 3.7566 |
| 35 10 | 3.7566 | 3.7567 | 3.7568 | 3.7569 | 3.7569 | 3.7570 | 3.7571 | 3.7572 | 3.7572 | 3.7573 |
| 35 20 | 3.7574 | 3.7575 | 3.7575 | 3.7576 | 3.7577 | 3.7578 | 3.7579 | 3.7579 | 3.7580 | 3.7581 |
| 35 30 | 3.7582 | 3.7582 | 3.7583 | 3.7584 | 3.7585 | 3.7585 | 3.7586 | 3.7587 | 3.7588 | 3.7588 |
| 35 40 | 3.7589 | 3.7590 | 3.7591 | 3.7591 | 3.7592 | 3.7593 | 3.7594 | 3.7594 | 3.7595 | 3.7596 |
| 35 50 | 3.7597 | 3.7597 | 3.7598 | 3.7599 | 3.7600 | 3.7600 | 3.7601 | 3.7602 | 3.7603 | 3.7603 |
| 1 36 0 | 3.7604 | 3.7605 | 3.7606 | 3.7606 | 3.7607 | 3.7608 | 3.7609 | 3.7609 | 3.7610 | 3.7611 |
| 36 10 | 3.7612 | 3.7613 | 3.7613 | 3.7614 | 3.7615 | 3.7616 | 3.7616 | 3.7617 | 3.7618 | 3.7619 |
| 36 20 | 3.7619 | 3.7620 | 3.7621 | 3.7622 | 3.7622 | 3.7623 | 3.7624 | 3.7625 | 3.7625 | 3.7626 |
| 36 30 | 3.7627 | 3.7628 | 3.7628 | 3.7629 | 3.7630 | 3.7631 | 3.7631 | 3.7632 | 3.7633 | 3.7634 |
| 36 40 | 3.7634 | 3.7635 | 3.7636 | 3.7637 | 3.7637 | 3.7638 | 3.7639 | 3.7640 | 3.7640 | 3.7641 |
| 36 50 | 3.7642 | 3.7643 | 3.7643 | 3.7644 | 3.7645 | 3.7645 | 3.7646 | 3.7647 | 3.7648 | 3.7648 |
| 1 37 0 | 3.7649 | 3.7650 | 3.7651 | 3.7651 | 3.7652 | 3.7653 | 3.7654 | 3.7654 | 3.7655 | 3.7656 |
| 37 10 | 3.7657 | 3.7657 | 3.7658 | 3.7659 | 3.7660 | 3.7660 | 3.7661 | 3.7662 | 3.7663 | 3.7663 |
| 37 20 | 3.7664 | 3.7665 | 3.7666 | 3.7666 | 3.7667 | 3.7668 | 3.7669 | 3.7669 | 3.7670 | 3.7671 |
| 37 30 | 3.7672 | 3.7672 | 3.7673 | 3.7674 | 3.7675 | 3.7675 | 3.7676 | 3.7677 | 3.7677 | 3.7678 |
| 37 40 | 3.7679 | 3.7680 | 3.7681 | 3.7681 | 3.7682 | 3.7683 | 3.7683 | 3.7684 | 3.7685 | 3.7686 |
| 37 50 | 3.7686 | 3.7687 | 3.7688 | 3.7689 | 3.7689 | 3.7690 | 3.7691 | 3.7692 | 3.7692 | 3.7693 |
| 1 38 0 | 3.7694 | 3.7695 | 3.7695 | 3.7696 | 3.7697 | 3.7697 | 3.7698 | 3.7699 | 3.7700 | 3.7700 |
| 38 10 | 3.7701 | 3.7702 | 3.7703 | 3.7703 | 3.7704 | 3.7705 | 3.7706 | 3.7706 | 3.7707 | 3.7708 |
| 38 20 | 3.7709 | 3.7709 | 3.7710 | 3.7711 | 3.7711 | 3.7712 | 3.7713 | 3.7714 | 3.7714 | 3.7715 |
| 38 30 | 3.7716 | 3.7717 | 3.7717 | 3.7718 | 3.7719 | 3.7720 | 3.7720 | 3.7721 | 3.7722 | 3.7722 |
| 38 40 | 3.7723 | 3.7724 | 3.7725 | 3.7725 | 3.7726 | 3.7727 | 3.7728 | 3.7728 | 3.7729 | 3.7730 |
| 38 50 | 3.7731 | 3.7731 | 3.7732 | 3.7733 | 3.7733 | 3.7734 | 3.7735 | 3.7736 | 3.7736 | 3.7737 |
| 1 39 0 | 3.7738 | 3.7739 | 3.7739 | 3.7740 | 3.7741 | 3.7742 | 3.7742 | 3.7743 | 3.7744 | 3.7744 |
| 39 10 | 3.7745 | 3.7746 | 3.7747 | 3.7747 | 3.7748 | 3.7749 | 3.7750 | 3.7750 | 3.7751 | 3.7752 |
| 39 20 | 3.7752 | 3.7753 | 3.7754 | 3.7755 | 3.7755 | 3.7756 | 3.7757 | 3.7758 | 3.7758 | 3.7759 |
| 39 30 | 3.7760 | 3.7760 | 3.7761 | 3.7762 | 3.7763 | 3.7763 | 3.7764 | 3.7765 | 3.7766 | 3.7766 |
| 39 40 | 3.7767 | 3.7768 | 3.7768 | 3.7769 | 3.7770 | 3.7771 | 3.7771 | 3.7772 | 3.7773 | 3.7774 |
| 39 50 | 3.7774 | 3.7775 | 3.7776 | 3.7776 | 3.7777 | 3.7778 | 3.7779 | 3.7779 | 3.7780 | 3.7781 |

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 1ʰ 40ᵐ | | 0ˢ | 3.7782 | 3.7782 | 3.7783 | 3.7784 | 3.7784 | 3.7785 | 3.7786 | 3.7787 | 3.7787 | 3.7788 |
| | 40 | 10 | 3.7789 | 3.7789 | 3.7790 | 3.7791 | 3.7792 | 3.7792 | 3.7793 | 3.7794 | 3.7795 | 3.7795 |
| | 40 | 20 | 3.7796 | 3.7797 | 3.7797 | 3.7798 | 3.7799 | 3.7800 | 3.7800 | 3.7801 | 3.7802 | 3.7802 |
| | 40 | 30 | 3.7803 | 3.7804 | 3.7805 | 3.7805 | 3.7806 | 3.7807 | 3.7807 | 3.7808 | 3.7809 | 3.7810 |
| | 40 | 40 | 3.7810 | 3.7811 | 3.7812 | 3.7813 | 3.7813 | 3.7814 | 3.7815 | 3.7815 | 3.7816 | 3.7817 |
| | 40 | 50 | 3.7818 | 3.7818 | 3.7819 | 3.7820 | 3.7820 | 3.7821 | 3.7822 | 3.7823 | 3.7823 | 3.7824 |
| 1 | 41 | 0 | 3.7825 | 3.7825 | 3.7826 | 3.7827 | 3.7828 | 3.7828 | 3.7829 | 3.7830 | 3.7830 | 3.7831 |
| | 41 | 10 | 3.7832 | 3.7833 | 3.7833 | 3.7834 | 3.7835 | 3.7835 | 3.7836 | 3.7837 | 3.7838 | 3.7838 |
| | 41 | 20 | 3.7839 | 3.7840 | 3.7840 | 3.7841 | 3.7842 | 3.7843 | 3.7843 | 3.7844 | 3.7845 | 3.7845 |
| | 41 | 30 | 3.7846 | 3.7847 | 3.7848 | 3.7848 | 3.7849 | 3.7850 | 3.7850 | 3.7851 | 3.7852 | 3.7853 |
| | 41 | 40 | 3.7853 | 3.7854 | 3.7855 | 3.7855 | 3.7856 | 3.7857 | 3.7858 | 3.7858 | 3.7859 | 3.7860 |
| | 41 | 50 | 3.7860 | 3.7861 | 3.7862 | 3.7863 | 3.7863 | 3.7864 | 3.7865 | 3.7865 | 3.7866 | 3.7867 |
| 1 | 42 | 0 | 3.7868 | 3.7868 | 3.7869 | 3.7870 | 3.7870 | 3.7871 | 3.7872 | 3.7872 | 3.7873 | 3.7874 |
| | 42 | 10 | 3.7875 | 3.7875 | 3.7876 | 3.7877 | 3.7877 | 3.7878 | 3.7879 | 3.7880 | 3.7880 | 3.7881 |
| | 42 | 20 | 3.7882 | 3.7882 | 3.7883 | 3.7884 | 3.7885 | 3.7885 | 3.7886 | 3.7887 | 3.7887 | 3.7888 |
| | 42 | 30 | 3.7889 | 3.7889 | 3.7890 | 3.7891 | 3.7892 | 3.7892 | 3.7893 | 3.7894 | 3.7894 | 3.7895 |
| | 42 | 40 | 3.7896 | 3.7897 | 3.7897 | 3.7898 | 3.7899 | 3.7899 | 3.7900 | 3.7901 | 3.7901 | 3.7902 |
| | 42 | 50 | 3.7903 | 3.7904 | 3.7904 | 3.7905 | 3.7906 | 3.7906 | 3.7907 | 3.7908 | 3.7908 | 3.7909 |
| 1 | 43 | 0 | 3.7910 | 3.7911 | 3.7911 | 3.7912 | 3.7913 | 3.7913 | 3.7914 | 3.7915 | 3.7916 | 3.7916 |
| | 43 | 10 | 3.7917 | 3.7918 | 3.7918 | 3.7919 | 3.7920 | 3.7920 | 3.7921 | 3.7922 | 3.7923 | 3.7923 |
| | 43 | 20 | 3.7924 | 3.7925 | 3.7925 | 3.7926 | 3.7927 | 3.7927 | 3.7928 | 3.7929 | 3.7930 | 3.7930 |
| | 43 | 30 | 3.7931 | 3.7932 | 3.7932 | 3.7933 | 3.7934 | 3.7934 | 3.7935 | 3.7936 | 3.7937 | 3.7937 |
| | 43 | 40 | 3.7938 | 3.7939 | 3.7939 | 3.7940 | 3.7941 | 3.7941 | 3.7942 | 3.7943 | 3.7943 | 3.7944 |
| | 43 | 50 | 3.7945 | 3.7946 | 3.7946 | 3.7947 | 3.7948 | 3.7948 | 3.7949 | 3.7950 | 3.7950 | 3.7951 |
| 1 | 44 | 0 | 3.7952 | 3.7953 | 3.7953 | 3.7954 | 3.7955 | 3.7955 | 3.7956 | 3.7957 | 3.7957 | 3.7958 |
| | 44 | 10 | 3.7959 | 3.7959 | 3.7960 | 3.7961 | 3.7962 | 3.7962 | 3.7963 | 3.7964 | 3.7964 | 3.7965 |
| | 44 | 20 | 3.7966 | 3.7966 | 3.7967 | 3.7968 | 3.7969 | 3.7969 | 3.7970 | 3.7971 | 3.7971 | 3.7972 |
| | 44 | 30 | 3.7973 | 3.7973 | 3.7974 | 3.7975 | 3.7975 | 3.7976 | 3.7977 | 3.7978 | 3.7978 | 3.7979 |
| | 44 | 40 | 3.7980 | 3.7980 | 3.7981 | 3.7982 | 3.7982 | 3.7983 | 3.7984 | 3.7984 | 3.7985 | 3.7986 |
| | 44 | 50 | 3.7987 | 3.7987 | 3.7988 | 3.7989 | 3.7989 | 3.7990 | 3.7991 | 3.7991 | 3.7992 | 3.7993 |
| 1 | 45 | 0 | 3.7993 | 3.7994 | 3.7995 | 3.7995 | 3.7996 | 3.7997 | 3.7998 | 3.7998 | 3.7999 | 3.8000 |
| | 45 | 10 | 3.8001 | 3.8001 | 3.8002 | 3.8002 | 3.8003 | 3.8004 | 3.8004 | 3.8005 | 3.8006 | 3.8006 |
| | 45 | 20 | 3.8007 | 3.8008 | 3.8009 | 3.8009 | 3.8010 | 3.8011 | 3.8011 | 3.8012 | 3.8013 | 3.8013 |
| | 45 | 30 | 3.8014 | 3.8015 | 3.8015 | 3.8016 | 3.8017 | 3.8017 | 3.8018 | 3.8019 | 3.8020 | 3.8020 |
| | 45 | 40 | 3.8021 | 3.8022 | 3.8022 | 3.8023 | 3.8024 | 3.8024 | 3.8025 | 3.8026 | 3.8026 | 3.8027 |
| | 45 | 50 | 3.8028 | 3.8028 | 3.8029 | 3.8030 | 3.8030 | 3.8031 | 3.8032 | 3.8033 | 3.8033 | 3.8034 |
| 1 | 46 | 0 | 3.8035 | 3.8035 | 3.8036 | 3.8036 | 3.8037 | 3.8038 | 3.8039 | 3.8039 | 3.8040 | 3.8041 |
| | 46 | 10 | 3.8041 | 3.8042 | 3.8043 | 3.8043 | 3.8044 | 3.8045 | 3.8045 | 3.8046 | 3.8047 | 3.8048 |
| | 46 | 20 | 3.8048 | 3.8049 | 3.8050 | 3.8050 | 3.8051 | 3.8052 | 3.8052 | 3.8053 | 3.8054 | 3.8054 |
| | 46 | 30 | 3.8055 | 3.8056 | 3.8056 | 3.8057 | 3.8058 | 3.8058 | 3.8059 | 3.8060 | 3.8060 | 3.8061 |
| | 46 | 40 | 3.8062 | 3.8062 | 3.8063 | 3.8064 | 3.8065 | 3.8065 | 3.8066 | 3.8067 | 3.8067 | 3.8068 |
| | 46 | 50 | 3.8069 | 3.8069 | 3.8070 | 3.8071 | 3.8071 | 3.8072 | 3.8073 | 3.8073 | 3.8074 | 3.8075 |
| 1 | 47 | 0 | 3.8075 | 3.8076 | 3.8077 | 3.8077 | 3.8078 | 3.8079 | 3.8079 | 3.8080 | 3.8081 | 3.8081 |
| | 47 | 10 | 3.8082 | 3.8083 | 3.8083 | 3.8084 | 3.8085 | 3.8085 | 3.8086 | 3.8087 | 3.8088 | 3.8088 |
| | 47 | 20 | 3.8089 | 3.8090 | 3.8090 | 3.8091 | 3.8092 | 3.8092 | 3.8093 | 3.8094 | 3.8094 | 3.8095 |
| | 47 | 30 | 3.8096 | 3.8096 | 3.8097 | 3.8098 | 3.8098 | 3.8099 | 3.8099 | 3.8100 | 3.8101 | 3.8102 |
| | 47 | 40 | 3.8102 | 3.8103 | 3.8104 | 3.8104 | 3.8105 | 3.8106 | 3.8106 | 3.8107 | 3.8108 | 3.8108 |
| | 47 | 50 | 3.8109 | 3.8110 | 3.8110 | 3.8111 | 3.8112 | 3.8112 | 3.8113 | 3.8114 | 3.8114 | 3.8115 |
| 1 | 48 | 0 | 3.8116 | 3.8116 | 3.8117 | 3.8118 | 3.8118 | 3.8119 | 3.8120 | 3.8120 | 3.8121 | 3.8122 |
| | 48 | 10 | 3.8122 | 3.8123 | 3.8124 | 3.8124 | 3.8125 | 3.8126 | 3.8126 | 3.8127 | 3.8128 | 3.8128 |
| | 48 | 20 | 3.8129 | 3.8130 | 3.8130 | 3.8131 | 3.8132 | 3.8132 | 3.8133 | 3.8134 | 3.8134 | 3.8135 |
| | 48 | 30 | 3.8136 | 3.8136 | 3.8137 | 3.8138 | 3.8138 | 3.8139 | 3.8140 | 3.8140 | 3.8141 | 3.8142 |
| | 48 | 40 | 3.8142 | 3.8143 | 3.8144 | 3.8144 | 3.8145 | 3.8146 | 3.8146 | 3.8147 | 3.8148 | 3.8148 |
| | 48 | 50 | 3.8149 | 3.8150 | 3.8150 | 3.8151 | 3.8152 | 3.8152 | 3.8153 | 3.8154 | 3.8154 | 3.8155 |
| 1 | 49 | 0 | 3.8156 | 3.8156 | 3.8157 | 3.8158 | 3.8158 | 3.8159 | 3.8160 | 3.8160 | 3.8161 | 3.8162 |
| | 49 | 10 | 3.8162 | 3.8163 | 3.8164 | 3.8164 | 3.8165 | 3.8166 | 3.8166 | 3.8167 | 3.8168 | 3.8168 |
| | 49 | 20 | 3.8169 | 3.8170 | 3.8170 | 3.8171 | 3.8172 | 3.8172 | 3.8173 | 3.8174 | 3.8174 | 3.8175 |
| | 49 | 30 | 3.8176 | 3.8176 | 3.8177 | 3.8178 | 3.8178 | 3.8179 | 3.8180 | 3.8180 | 3.8181 | 3.8182 |
| | 49 | 40 | 3.8182 | 3.8183 | 3.8184 | 3.8184 | 3.8185 | 3.8185 | 3.8186 | 3.8187 | 3.8188 | 3.8188 |
| | 49 | 50 | 3.8189 | 3.8190 | 3.8190 | 3.8191 | 3.8191 | 3.8192 | 3.8193 | 3.8193 | 3.8194 | 3.8195 |

# APPENDIX V: TABLE IX.

### Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 1ʰ 50ᵐ | | 0ˢ | 3.8195 | 3.8196 | 3.8197 | 3.8197 | 3.8198 | 3.8199 | 3.8199 | 3.8200 | 3.8201 | 3.8201 |
| | 50 | 10 | 3.8202 | 3.8203 | 3.8203 | 3.8204 | 3.8205 | 3.8205 | 3.8206 | 3.8207 | 3.8207 | 3.8208 |
| | 50 | 20 | 3.8209 | 3.8209 | 3.8210 | 3.8211 | 3.8211 | 3.8212 | 3.8213 | 3.8213 | 3.8214 | 3.8214 |
| | 50 | 30 | 3.8215 | 3.8216 | 3.8216 | 3.8217 | 3.8218 | 3.8218 | 3.8219 | 3.8220 | 3.8220 | 3.8221 |
| | 50 | 40 | 3.8222 | 3.8222 | 3.8223 | 3.8224 | 3.8224 | 3.8225 | 3.8226 | 3.8226 | 3.8227 | 3.8228 |
| | 50 | 50 | 3.8228 | 3.8229 | 3.8230 | 3.8230 | 3.8231 | 3.8231 | 3.8232 | 3.8233 | 3.8233 | 3.8234 |
| 1 | 51 | 0 | 3.8235 | 3.8235 | 3.8236 | 3.8237 | 3.8237 | 3.8238 | 3.8239 | 3.8239 | 3.8240 | 3.8241 |
| | 51 | 10 | 3.8241 | 3.8242 | 3.8243 | 3.8243 | 3.8244 | 3.8245 | 3.8245 | 3.8246 | 3.8246 | 3.8247 |
| | 51 | 20 | 3.8248 | 3.8248 | 3.8249 | 3.8250 | 3.8250 | 3.8251 | 3.8252 | 3.8252 | 3.8253 | 3.8254 |
| | 51 | 30 | 3.8254 | 3.8255 | 3.8256 | 3.8256 | 3.8257 | 3.8258 | 3.8258 | 3.8259 | 3.8259 | 3.8260 |
| | 51 | 40 | 3.8261 | 3.8261 | 3.8262 | 3.8263 | 3.8263 | 3.8264 | 3.8265 | 3.8265 | 3.8266 | 3.8267 |
| | 51 | 50 | 3.8267 | 3.8268 | 3.8269 | 3.8269 | 3.8270 | 3.8270 | 3.8271 | 3.8272 | 3.8272 | 3.8273 |
| 1 | 52 | 0 | 3.8274 | 3.8274 | 3.8275 | 3.8276 | 3.8276 | 3.8277 | 3.8278 | 3.8278 | 3.8279 | 3.8280 |
| | 52 | 10 | 3.8280 | 3.8281 | 3.8281 | 3.8282 | 3.8283 | 3.8283 | 3.8284 | 3.8285 | 3.8285 | 3.8286 |
| | 52 | 20 | 3.8287 | 3.8287 | 3.8288 | 3.8289 | 3.8289 | 3.8290 | 3.8290 | 3.8291 | 3.8292 | 3.8292 |
| | 52 | 30 | 3.8293 | 3.8294 | 3.8294 | 3.8295 | 3.8296 | 3.8296 | 3.8297 | 3.8298 | 3.8298 | 3.8299 |
| | 52 | 40 | 3.8299 | 3.8300 | 3.8301 | 3.8301 | 3.8302 | 3.8303 | 3.8303 | 3.8304 | 3.8305 | 3.8305 |
| | 52 | 50 | 3.8306 | 3.8307 | 3.8307 | 3.8308 | 3.8308 | 3.8309 | 3.8310 | 3.8310 | 3.8311 | 3.8312 |
| 1 | 53 | 0 | 3.8312 | 3.8313 | 3.8314 | 3.8314 | 3.8315 | 3.8315 | 3.8316 | 3.8317 | 3.8317 | 3.8318 |
| | 53 | 10 | 3.8319 | 3.8319 | 3.8320 | 3.8321 | 3.8321 | 3.8322 | 3.8323 | 3.8323 | 3.8324 | 3.8324 |
| | 53 | 20 | 3.8325 | 3.8326 | 3.8326 | 3.8327 | 3.8328 | 3.8328 | 3.8329 | 3.8330 | 3.8330 | 3.8331 |
| | 53 | 30 | 3.8331 | 3.8332 | 3.8333 | 3.8333 | 3.8334 | 3.8335 | 3.8335 | 3.8336 | 3.8337 | 3.8337 |
| | 53 | 40 | 3.8338 | 3.8338 | 3.8339 | 3.8340 | 3.8340 | 3.8341 | 3.8342 | 3.8342 | 3.8343 | 3.8344 |
| | 53 | 50 | 3.8345 | 3.8345 | 3.8346 | 3.8346 | 3.8347 | 3.8347 | 3.8348 | 3.8349 | 3.8349 | 3.8350 |
| 1 | 54 | 0 | 3.8351 | 3.8351 | 3.8352 | 3.8352 | 3.8353 | 3.8354 | 3.8354 | 3.8355 | 3.8356 | 3.8356 |
| | 54 | 10 | 3.8357 | 3.8358 | 3.8358 | 3.8359 | 3.8359 | 3.8360 | 3.8361 | 3.8361 | 3.8362 | 3.8363 |
| | 54 | 20 | 3.8363 | 3.8364 | 3.8365 | 3.8365 | 3.8366 | 3.8366 | 3.8367 | 3.8368 | 3.8368 | 3.8369 |
| | 54 | 30 | 3.8370 | 3.8370 | 3.8371 | 3.8371 | 3.8372 | 3.8373 | 3.8373 | 3.8374 | 3.8375 | 3.8375 |
| | 54 | 40 | 3.8376 | 3.8377 | 3.8377 | 3.8378 | 3.8378 | 3.8379 | 3.8380 | 3.8380 | 3.8381 | 3.8382 |
| | 54 | 50 | 3.8382 | 3.8383 | 3.8383 | 3.8384 | 3.8385 | 3.8385 | 3.8386 | 3.8387 | 3.8387 | 3.8388 |
| 1 | 55 | 0 | 3.8388 | 3.8389 | 3.8390 | 3.8390 | 3.8391 | 3.8392 | 3.8392 | 3.8393 | 3.8394 | 3.8394 |
| | 55 | 10 | 3.8395 | 3.8395 | 3.8396 | 3.8397 | 3.8397 | 3.8398 | 3.8399 | 3.8399 | 3.8400 | 3.8400 |
| | 55 | 20 | 3.8401 | 3.8402 | 3.8402 | 3.8403 | 3.8404 | 3.8404 | 3.8405 | 3.8405 | 3.8406 | 3.8407 |
| | 55 | 30 | 3.8407 | 3.8408 | 3.8409 | 3.8409 | 3.8410 | 3.8410 | 3.8411 | 3.8412 | 3.8412 | 3.8413 |
| | 55 | 40 | 3.8414 | 3.8414 | 3.8415 | 3.8415 | 3.8416 | 3.8417 | 3.8417 | 3.8418 | 3.8419 | 3.8419 |
| | 55 | 50 | 3.8420 | 3.8420 | 3.8421 | 3.8422 | 3.8422 | 3.8423 | 3.8424 | 3.8424 | 3.8425 | 3.8425 |
| 1 | 56 | 0 | 3.8426 | 3.8427 | 3.8427 | 3.8428 | 3.8429 | 3.8429 | 3.8430 | 3.8430 | 3.8431 | 3.8432 |
| | 56 | 10 | 3.8432 | 3.8433 | 3.8434 | 3.8434 | 3.8435 | 3.8435 | 3.8436 | 3.8437 | 3.8437 | 3.8438 |
| | 56 | 20 | 3.8439 | 3.8439 | 3.8440 | 3.8440 | 3.8441 | 3.8442 | 3.8442 | 3.8443 | 3.8444 | 3.8444 |
| | 56 | 30 | 3.8445 | 3.8445 | 3.8446 | 3.8447 | 3.8447 | 3.8448 | 3.8448 | 3.8449 | 3.8450 | 3.8450 |
| | 56 | 40 | 3.8451 | 3.8452 | 3.8452 | 3.8453 | 3.8453 | 3.8454 | 3.8455 | 3.8455 | 3.8456 | 3.8457 |
| | 56 | 50 | 3.8457 | 3.8458 | 3.8458 | 3.8459 | 3.8460 | 3.8460 | 3.8461 | 3.8462 | 3.8462 | 3.8463 |
| 1 | 57 | 0 | 3.8463 | 3.8464 | 3.8465 | 3.8465 | 3.8466 | 3.8466 | 3.8467 | 3.8468 | 3.8468 | 3.8469 |
| | 57 | 10 | 3.8470 | 3.8470 | 3.8471 | 3.8471 | 3.8472 | 3.8473 | 3.8473 | 3.8474 | 3.8474 | 3.8475 |
| | 57 | 20 | 3.8476 | 3.8476 | 3.8477 | 3.8478 | 3.8478 | 3.8479 | 3.8479 | 3.8480 | 3.8481 | 3.8481 |
| | 57 | 30 | 3.8482 | 3.8483 | 3.8483 | 3.8484 | 3.8484 | 3.8485 | 3.8486 | 3.8486 | 3.8487 | 3.8487 |
| | 57 | 40 | 3.8488 | 3.8489 | 3.8489 | 3.8490 | 3.8491 | 3.8491 | 3.8492 | 3.8492 | 3.8493 | 3.8494 |
| | 57 | 50 | 3.8494 | 3.8495 | 3.8495 | 3.8496 | 3.8497 | 3.8497 | 3.8498 | 3.8499 | 3.8499 | 3.8500 |
| 1 | 58 | 0 | 3.8500 | 3.8501 | 3.8502 | 3.8502 | 3.8503 | 3.8503 | 3.8504 | 3.8505 | 3.8505 | 3.8506 |
| | 58 | 10 | 3.8506 | 3.8507 | 3.8508 | 3.8508 | 3.8509 | 3.8510 | 3.8510 | 3.8511 | 3.8511 | 3.8512 |
| | 58 | 20 | 3.8513 | 3.8513 | 3.8514 | 3.8514 | 3.8515 | 3.8516 | 3.8516 | 3.8517 | 3.8517 | 3.8518 |
| | 58 | 30 | 3.8519 | 3.8519 | 3.8520 | 3.8521 | 3.8521 | 3.8522 | 3.8522 | 3.8523 | 3.8524 | 3.8524 |
| | 58 | 40 | 3.8525 | 3.8525 | 3.8526 | 3.8527 | 3.8527 | 3.8528 | 3.8528 | 3.8529 | 3.8530 | 3.8530 |
| | 58 | 50 | 3.8531 | 3.8532 | 3.8532 | 3.8533 | 3.8533 | 3.8534 | 3.8535 | 3.8535 | 3.8536 | 3.8536 |
| 1 | 59 | 0 | 3.8537 | 3.8538 | 3.8538 | 3.8539 | 3.8539 | 3.8540 | 3.8541 | 3.8541 | 3.8542 | 3.8542 |
| | 59 | 10 | 3.8543 | 3.8544 | 3.8544 | 3.8545 | 3.8545 | 3.8546 | 3.8547 | 3.8547 | 3.8548 | 3.8549 |
| | 59 | 20 | 3.8549 | 3.8550 | 3.8550 | 3.8551 | 3.8552 | 3.8552 | 3.8553 | 3.8553 | 3.8554 | 3.8555 |
| | 59 | 30 | 3.8555 | 3.8556 | 3.8556 | 3.8557 | 3.8558 | 3.8558 | 3.8559 | 3.8559 | 3.8560 | 3.8561 |
| | 59 | 40 | 3.8561 | 3.8562 | 3.8562 | 3.8563 | 3.8564 | 3.8564 | 3.8565 | 3.8565 | 3.8566 | 3.8567 |
| | 59 | 50 | 3.8567 | 3.8568 | 3.8568 | 3.8569 | 3.8570 | 3.8570 | 3.8571 | 3.8572 | 3.8572 | 3.8573 |

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 2ʰ | 0ᵐ | 0ˢ | 3.8573 | 3.8574 | 3.8575 | 3.8575 | 3.8576 | 3.8576 | 3.8577 | 3.8578 | 3.8578 | 3.8579 |
| | 0 | 10 | 3.8579 | 3.8580 | 3.8581 | 3.8581 | 3.8582 | 3.8582 | 3.8583 | 3.8584 | 3.8584 | 3.8585 |
| | 0 | 20 | 3.8585 | 3.8586 | 3.8587 | 3.8587 | 3.8588 | 3.8588 | 3.8589 | 3.8590 | 3.8590 | 3.8591 |
| | 0 | 30 | 3.8591 | 3.8592 | 3.8593 | 3.8593 | 3.8594 | 3.8594 | 3.8595 | 3.8596 | 3.8596 | 3.8597 |
| | 0 | 40 | 3.8597 | 3.8598 | 3.8599 | 3.8599 | 3.8600 | 3.8600 | 3.8601 | 3.8602 | 3.8602 | 3.8603 |
| | 0 | 50 | 3.8603 | 3.8604 | 3.8605 | 3.8605 | 3.8606 | 3.8606 | 3.8607 | 3.8608 | 3.8608 | 3.8609 |
| 2 | 1 | 0 | 3.8609 | 3.8610 | 3.8611 | 3.8611 | 3.8612 | 3.8612 | 3.8613 | 3.8614 | 3.8614 | 3.8615 |
| | 1 | 10 | 3.8615 | 3.8616 | 3.8617 | 3.8617 | 3.8618 | 3.8618 | 3.8619 | 3.8620 | 3.8620 | 3.8621 |
| | 1 | 20 | 3.8621 | 3.8622 | 3.8623 | 3.8623 | 3.8624 | 3.8624 | 3.8625 | 3.8625 | 3.8626 | 3.8627 |
| | 1 | 30 | 3.8627 | 3.8628 | 3.8628 | 3.8629 | 3.8630 | 3.8630 | 3.8631 | 3.8631 | 3.8632 | 3.8633 |
| | 1 | 40 | 3.8633 | 3.8634 | 3.8634 | 3.8635 | 3.8636 | 3.8636 | 3.8637 | 3.8637 | 3.8638 | 3.8639 |
| | 1 | 50 | 3.8639 | 3.8640 | 3.8640 | 3.8641 | 3.8642 | 3.8642 | 3.8643 | 3.8643 | 3.8644 | 3.8645 |
| 2 | 2 | 0 | 3.8645 | 3.8646 | 3.8646 | 3.8647 | 3.8647 | 3.8648 | 3.8649 | 3.8649 | 3.8650 | 3.8650 |
| | 2 | 10 | 3.8651 | 3.8652 | 3.8652 | 3.8653 | 3.8653 | 3.8654 | 3.8655 | 3.8655 | 3.8656 | 3.8656 |
| | 2 | 20 | 3.8657 | 3.8658 | 3.8658 | 3.8659 | 3.8659 | 3.8660 | 3.8661 | 3.8661 | 3.8662 | 3.8662 |
| | 2 | 30 | 3.8663 | 3.8663 | 3.8664 | 3.8665 | 3.8665 | 3.8666 | 3.8666 | 3.8667 | 3.8668 | 3.8668 |
| | 2 | 40 | 3.8669 | 3.8669 | 3.8670 | 3.8671 | 3.8671 | 3.8672 | 3.8672 | 3.8673 | 3.8673 | 3.8674 |
| | 2 | 50 | 3.8675 | 3.8675 | 3.8676 | 3.8676 | 3.8677 | 3.8678 | 3.8678 | 3.8679 | 3.8679 | 3.8680 |
| 2 | 3 | 0 | 3.8681 | 3.8681 | 3.8682 | 3.8682 | 3.8683 | 3.8684 | 3.8684 | 3.8685 | 3.8685 | 3.8686 |
| | 3 | 10 | 3.8686 | 3.8687 | 3.8688 | 3.8688 | 3.8689 | 3.8689 | 3.8690 | 3.8691 | 3.8691 | 3.8692 |
| | 3 | 20 | 3.8692 | 3.8693 | 3.8693 | 3.8694 | 3.8695 | 3.8695 | 3.8696 | 3.8696 | 3.8697 | 3.8698 |
| | 3 | 30 | 3.8698 | 3.8699 | 3.8699 | 3.8700 | 3.8701 | 3.8701 | 3.8702 | 3.8702 | 3.8703 | 3.8703 |
| | 3 | 40 | 3.8704 | 3.8705 | 3.8705 | 3.8706 | 3.8706 | 3.8707 | 3.8708 | 3.8708 | 3.8709 | 3.8709 |
| | 3 | 50 | 3.8710 | 3.8710 | 3.8711 | 3.8712 | 3.8712 | 3.8713 | 3.8713 | 3.8714 | 3.8715 | 3.8715 |
| 2 | 4 | 0 | 3.8716 | 3.8716 | 3.8717 | 3.8717 | 3.8718 | 3.8719 | 3.8719 | 3.8720 | 3.8720 | 3.8721 |
| | 4 | 10 | 3.8722 | 3.8722 | 3.8723 | 3.8723 | 3.8724 | 3.8724 | 3.8725 | 3.8726 | 3.8726 | 3.8727 |
| | 4 | 20 | 3.8727 | 3.8728 | 3.8729 | 3.8729 | 3.8730 | 3.8730 | 3.8731 | 3.8731 | 3.8732 | 3.8733 |
| | 4 | 30 | 3.8733 | 3.8734 | 3.8734 | 3.8735 | 3.8736 | 3.8736 | 3.8737 | 3.8737 | 3.8738 | 3.8738 |
| | 4 | 40 | 3.8739 | 3.8740 | 3.8740 | 3.8741 | 3.8741 | 3.8742 | 3.8742 | 3.8743 | 3.8744 | 3.8744 |
| | 4 | 50 | 3.8745 | 3.8745 | 3.8746 | 3.8747 | 3.8747 | 3.8748 | 3.8748 | 3.8749 | 3.8749 | 3.8750 |
| 2 | 5 | 0 | 3.8751 | 3.8751 | 3.8752 | 3.8752 | 3.8753 | 3.8754 | 3.8754 | 3.8755 | 3.8755 | 3.8756 |
| | 5 | 10 | 3.8756 | 3.8757 | 3.8758 | 3.8758 | 3.8759 | 3.8759 | 3.8760 | 3.8760 | 3.8761 | 3.8762 |
| | 5 | 20 | 3.8762 | 3.8763 | 3.8763 | 3.8764 | 3.8764 | 3.8765 | 3.8766 | 3.8766 | 3.8767 | 3.8767 |
| | 5 | 30 | 3.8768 | 3.8769 | 3.8769 | 3.8770 | 3.8770 | 3.8771 | 3.8771 | 3.8772 | 3.8773 | 3.8773 |
| | 5 | 40 | 3.8774 | 3.8774 | 3.8775 | 3.8775 | 3.8776 | 3.8777 | 3.8777 | 3.8778 | 3.8778 | 3.8779 |
| | 5 | 50 | 3.8779 | 3.8780 | 3.8781 | 3.8781 | 3.8782 | 3.8782 | 3.8783 | 3.8783 | 3.8784 | 3.8785 |
| 2 | 6 | 0 | 3.8785 | 3.8786 | 3.8786 | 3.8787 | 3.8788 | 3.8788 | 3.8789 | 3.8789 | 3.8790 | 3.8790 |
| | 6 | 10 | 3.8791 | 3.8792 | 3.8792 | 3.8793 | 3.8793 | 3.8794 | 3.8794 | 3.8795 | 3.8796 | 3.8796 |
| | 6 | 20 | 3.8797 | 3.8797 | 3.8798 | 3.8798 | 3.8799 | 3.8800 | 3.8800 | 3.8801 | 3.8801 | 3.8802 |
| | 6 | 30 | 3.8802 | 3.8803 | 3.8804 | 3.8804 | 3.8805 | 3.8805 | 3.8806 | 3.8806 | 3.8807 | 3.8808 |
| | 6 | 40 | 3.8808 | 3.8809 | 3.8809 | 3.8810 | 3.8810 | 3.8811 | 3.8812 | 3.8812 | 3.8813 | 3.8813 |
| | 6 | 50 | 3.8814 | 3.8814 | 3.8815 | 3.8816 | 3.8816 | 3.8817 | 3.8817 | 3.8818 | 3.8818 | 3.8819 |
| 2 | 7 | 0 | 3.8820 | 3.8820 | 3.8821 | 3.8821 | 3.8822 | 3.8822 | 3.8823 | 3.8824 | 3.8824 | 3.8825 |
| | 7 | 10 | 3.8825 | 3.8826 | 3.8826 | 3.8827 | 3.8828 | 3.8828 | 3.8829 | 3.8829 | 3.8830 | 3.8830 |
| | 7 | 20 | 3.8831 | 3.8832 | 3.8832 | 3.8833 | 3.8833 | 3.8834 | 3.8834 | 3.8835 | 3.8835 | 3.8836 |
| | 7 | 30 | 3.8837 | 3.8837 | 3.8838 | 3.8838 | 3.8839 | 3.8839 | 3.8840 | 3.8841 | 3.8841 | 3.8842 |
| | 7 | 40 | 3.8842 | 3.8843 | 3.8843 | 3.8844 | 3.8845 | 3.8845 | 3.8846 | 3.8846 | 3.8847 | 3.8847 |
| | 7 | 50 | 3.8848 | 3.8849 | 3.8849 | 3.8850 | 3.8850 | 3.8851 | 3.8851 | 3.8852 | 3.8852 | 3.8853 |
| 2 | 8 | 0 | 3.8854 | 3.8854 | 3.8855 | 3.8855 | 3.8856 | 3.8856 | 3.8857 | 3.8858 | 3.8858 | 3.8859 |
| | 8 | 10 | 3.8859 | 3.8860 | 3.8860 | 3.8861 | 3.8862 | 3.8862 | 3.8863 | 3.8863 | 3.8864 | 3.8864 |
| | 8 | 20 | 3.8865 | 3.8865 | 3.8866 | 3.8867 | 3.8867 | 3.8868 | 3.8868 | 3.8869 | 3.8869 | 3.8870 |
| | 8 | 30 | 3.8871 | 3.8871 | 3.8872 | 3.8872 | 3.8873 | 3.8873 | 3.8874 | 3.8874 | 3.8875 | 3.8876 |
| | 8 | 40 | 3.8876 | 3.8877 | 3.8877 | 3.8878 | 3.8878 | 3.8879 | 3.8880 | 3.8880 | 3.8881 | 3.8881 |
| | 8 | 50 | 3.8882 | 3.8882 | 3.8883 | 3.8883 | 3.8884 | 3.8885 | 3.8885 | 3.8886 | 3.8886 | 3.8887 |
| 2 | 9 | 0 | 3.8887 | 3.8888 | 3.8889 | 3.8889 | 3.8890 | 3.8890 | 3.8891 | 3.8891 | 3.8892 | 3.8892 |
| | 9 | 10 | 3.8893 | 3.8894 | 3.8894 | 3.8895 | 3.8895 | 3.8896 | 3.8896 | 3.8897 | 3.8897 | 3.8898 |
| | 9 | 20 | 3.8899 | 3.8899 | 3.8900 | 3.8900 | 3.8901 | 3.8901 | 3.8902 | 3.8903 | 3.8903 | 3.8904 |
| | 9 | 30 | 3.8904 | 3.8905 | 3.8905 | 3.8906 | 3.8906 | 3.8907 | 3.8908 | 3.8908 | 3.8909 | 3.8909 |
| | 9 | 40 | 3.8910 | 3.8910 | 3.8911 | 3.8911 | 3.8912 | 3.8912 | 3.8913 | 3.8914 | 3.8914 | 3.8915 |
| | 9 | 50 | 3.8915 | 3.8916 | 3.8916 | 3.8917 | 3.8918 | 3.8918 | 3.8919 | 3.8919 | 3.8920 | 3.8920 |

# APPENDIX V: TABLE IX.

## Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 2ʰ 10ᵐ | | 0ˢ | 3.8921 | 3.8922 | 3.8922 | 3.8923 | 3.8923 | 3.8924 | 3.8924 | 3.8925 | 3.8925 | 3.8926 |
| | 10 | 10 | 3.8927 | 3.8927 | 3.8928 | 3.8928 | 3.8929 | 3.8929 | 3.8930 | 3.8930 | 3.8931 | 3.8932 |
| | 10 | 20 | 3.8932 | 3.8933 | 3.8933 | 3.8934 | 3.8934 | 3.8935 | 3.8935 | 3.8936 | 3.8937 | 3.8937 |
| | 10 | 30 | 3.8938 | 3.8938 | 3.8939 | 3.8939 | 3.8940 | 3.8940 | 3.8941 | 3.8941 | 3.8942 | 3.8943 |
| | 10 | 40 | 3.8943 | 3.8944 | 3..8944 | 3.8945 | 3.8945 | 3.8946 | 3.8946 | 3.8947 | 3.8948 | 3.8948 |
| | 10 | 50 | 3.8949 | 3.8949 | 3.8950 | 3.8950 | 3.8951 | 3.8951 | 3.8952 | 3.8953 | 3.8953 | 3.8954 |
| 2 | 11 | 0 | 3.8954 | 3.8955 | 3.8955 | 3.8956 | 3.8956 | 3.8957 | 3.8958 | 3.8958 | 3.8959 | 3.8959 |
| | 11 | 10 | 3.8960 | 3.8960 | 3.8961 | 3.8961 | 3.8962 | 3.8963 | 3.8963 | 3.8964 | 3.8964 | 3.8965 |
| | 11 | 20 | 3.8965 | 3.8966 | 3.8966 | 3.8967 | 3.8967 | 3.8968 | 3.8969 | 3.8969 | 3.8970 | 3.8970 |
| | 11 | 30 | 3.8971 | 3.8971 | 3.8972 | 3.8972 | 3.8973 | 3.8974 | 3.8974 | 3.8975 | 3.8975 | 3.8976 |
| | 11 | 40 | 3.8976 | 3.8977 | 3.8977 | 3.8978 | 3.8978 | 3.8979 | 3.8980 | 3.8980 | 3.8981 | 3.8981 |
| | 11 | 50 | 3.8982 | 3.8982 | 3.8983 | 3.8983 | 3.8984 | 3.8985 | 3.8985 | 3.8986 | 3.8986 | 3.8987 |
| 2 | 12 | 0 | 3.8987 | 3.8988 | 3.8988 | 3.8989 | 3.8989 | 3.8990 | 3.8991 | 3.8991 | 3.8992 | 3.8992 |
| | 12 | 10 | 3.8993 | 3.8993 | 3.8994 | 3.8994 | 3.8995 | 3.8995 | 3.8996 | 3.8997 | 3.8997 | 3.8998 |
| | 12 | 20 | 3.8998 | 3.8999 | 3.8999 | 3.9000 | 3.9000 | 3.9001 | 3.9001 | 3.9002 | 3.9003 | 3.9003 |
| | 12 | 30 | 3.9004 | 3.9004 | 3.9005 | 3.9005 | 3.9006 | 3.9006 | 3.9007 | 3.9007 | 3.9008 | 3.9009 |
| | 12 | 40 | 3.9009 | 3.9010 | 3.9010 | 3.9011 | 3.9011 | 3.9012 | 3.9012 | 3.9013 | 3.9013 | 3.9014 |
| | 12 | 50 | 3.9015 | 3.9015 | 3.9016 | 3.9016 | 3.9017 | 3.9017 | 3.9018 | 3.9018 | 3.9019 | 3.9019 |
| 2 | 13 | 0 | 3.9020 | 3.9021 | 3.9021 | 3.9022 | 3.9022 | 3.9023 | 3.9023 | 3.9024 | 3.9024 | 3.9025 |
| | 13 | 10 | 3.9025 | 3.9026 | 3.9027 | 3.9027 | 3.9028 | 3.9028 | 3.9029 | 3.9029 | 3.9030 | 3.9030 |
| | 13 | 20 | 3.9031 | 3.9031 | 3.9032 | 3.9033 | 3.9033 | 3.9034 | 3.9034 | 3.9035 | 3.9035 | 3.9036 |
| | 13 | 30 | 3.9036 | 3.9037 | 3.9037 | 3.9038 | 3.9038 | 3.9039 | 3.9040 | 3.9040 | 3.9041 | 3.9041 |
| | 13 | 40 | 3.9042 | 3.9042 | 3.9043 | 3.9043 | 3.9044 | 3.9044 | 3.9045 | 3.9046 | 3.9046 | 3.9047 |
| | 13 | 50 | 3.9047 | 3.9048 | 3.9048 | 3.9049 | 3.9049 | 3.9050 | 3.9050 | 3.9051 | 3.9051 | 3.9052 |
| 2 | 14 | 0 | 3.9053 | 3.9053 | 3.9054 | 3.9054 | 3.9055 | 3.9055 | 3.9056 | 3.9056 | 3.9057 | 3.9057 |
| | 14 | 10 | 3.9058 | 3.9058 | 3.9059 | 3.9060 | 3.9060 | 3.9061 | 3.9061 | 3.9062 | 3.9062 | 3.9063 |
| | 14 | 20 | 3.9063 | 3.9064 | 3.9064 | 3.9065 | 3.9066 | 3.9066 | 3.9067 | 3.9067 | 3.9068 | 3.9068 |
| | 14 | 30 | 3.9069 | 3.9069 | 3.9070 | 3.9070 | 3.9071 | 3.9071 | 3.9072 | 3.9073 | 3.9073 | 3.9074 |
| | 14 | 40 | 3.9074 | 3.9075 | 3.9075 | 3.9076 | 3.9076 | 3.9077 | 3.9077 | 3.9078 | 3.9078 | 3.9079 |
| | 14 | 50 | 3.9079 | 3.9080 | 3.9081 | 3.9081 | 3.9082 | 3.9082 | 3.9083 | 3.9083 | 3.9084 | 3.9084 |
| 2 | 15 | 0 | 3.9085 | 3.9085 | 3.9086 | 3.9086 | 3.9087 | 3.9088 | 3.9088 | 3.9089 | 3.9089 | 3.9090 |
| | 15 | 10 | 3.9090 | 3.9091 | 3.9091 | 3.9092 | 3.9092 | 3.9093 | 3.9093 | 3.9094 | 3.9094 | 3.9095 |
| | 15 | 20 | 3.9096 | 3.9096 | 3.9097 | 3.9097 | 3.9098 | 3.9098 | 3.9099 | 3.9099 | 3.9100 | 3.9100 |
| | 15 | 30 | 3.9101 | 3.9101 | 3.9102 | 3.9103 | 3.9103 | 3.9104 | 3.9104 | 3.9105 | 3.9105 | 3.9106 |
| | 15 | 40 | 3.9106 | 3.9107 | 3.9107 | 3.9108 | 3.9108 | 3.9109 | 3.9109 | 3.9110 | 3.9111 | 3.9111 |
| | 15 | 50 | 3.9112 | 3.9112 | 3.9113 | 3.9113 | 3.9114 | 3.9114 | 3.9115 | 3.9115 | 3.9116 | 3.9116 |
| 2 | 16 | 0 | 3.9117 | 3.9117 | 3.9118 | 3.9118 | 3.9119 | 3.9120 | 3.9120 | 3.9121 | 3.9121 | 3.9122 |
| | 16 | 10 | 3.9122 | 3.9123 | 3.9123 | 3.9124 | 3.9124 | 3.9125 | 3.9125 | 3.9126 | 3.9126 | 3.9127 |
| | 16 | 20 | 3.9128 | 3.9128 | 3.9129 | 3.9129 | 3.9130 | 3.9130 | 3.9131 | 3.9131 | 3.9132 | 3.9132 |
| | 16 | 30 | 3.9133 | 3.9133 | 3.9134 | 3.9134 | 3.9135 | 3.9135 | 3.9136 | 3.9137 | 3.9137 | 3.9138 |
| | 16 | 40 | 3.9138 | 3.9139 | 3.9139 | 3.9140 | 3.9140 | 3.9141 | 3.9141 | 3.9142 | 3.9142 | 3.9143 |
| | 16 | 50 | 3.9143 | 3.9144 | 3.9144 | 3.9145 | 3.9146 | 3.9146 | 3.9147 | 3.9147 | 3.9148 | 3.9148 |
| 2 | 17 | 0 | 3.9149 | 3.9149 | 3.9150 | 3.9150 | 3.9151 | 3.9151 | 3.9152 | 3.9152 | 3.9153 | 3.9153 |
| | 17 | 10 | 3.9154 | 3.9155 | 3.9155 | 3.9156 | 3.9156 | 3.9157 | 3.9157 | 3.9158 | 3.9158 | 3.9159 |
| | 17 | 20 | 3.9159 | 3.9160 | 3.9160 | 3.9161 | 3.9161 | 3.9162 | 3.9162 | 3.9163 | 3.9163 | 3.9164 |
| | 17 | 30 | 3.9165 | 3.9165 | 3.9166 | 3.9166 | 3.9167 | 3.9167 | 3.9168 | 3.9168 | 3.9169 | 3.9169 |
| | 17 | 40 | 3.9170 | 3.9170 | 3.9171 | 3.9171 | 3.9172 | 3.9172 | 3.9173 | 3.9173 | 3.9174 | 3.9175 |
| | 17 | 50 | 3.9175 | 3.9176 | 3.9176 | 3.9177 | 3.9177 | 3.9178 | 3.9178 | 3.9179 | 3.9179 | 3.9180 |
| 2 | 18 | 0 | 3.9180 | 3.9181 | 3.9181 | 3.9182 | 3.9182 | 3.9183 | 3.9183 | 3.9184 | 3.9184 | 3.9185 |
| | 18 | 10 | 3.9186 | 3.9186 | 3.9187 | 3.9187 | 3.9188 | 3.9188 | 3.9189 | 3.9189 | 3.9190 | 3.9190 |
| | 18 | 20 | 3.9191 | 3.9191 | 3.9192 | 3.9192 | 3.9193 | 3.9193 | 3.9194 | 3.9194 | 3.9195 | 3.9195 |
| | 18 | 30 | 3.9196 | 3.9197 | 3.9197 | 3.9198 | 3.9198 | 3.9199 | 3.9199 | 3.9200 | 3.9200 | 3.9201 |
| | 18 | 40 | 3.9201 | 3.9202 | 3.9202 | 3.9203 | 3.9203 | 3.9204 | 3.9204 | 3.9205 | 3.9205 | 3.9206 |
| | 18 | 50 | 3.9206 | 3.9207 | 3.9207 | 3.9208 | 3.9209 | 3.9209 | 3.9210 | 3.9210 | 3.9211 | 3.9211 |
| 2 | 19 | 0 | 3.9212 | 3.9212 | 3.9213 | 3.9213 | 3.9214 | 3.9214 | 3.9215 | 3.9215 | 3.9216 | 3.9216 |
| | 19 | 10 | 3.9217 | 3.9217 | 3.9218 | 3.9218 | 3.9219 | 3.9219 | 3.9220 | 3.9221 | 3.9221 | 3.9222 |
| | 19 | 20 | 3.9222 | 3.9223 | 3.9223 | 3.9224 | 3.9224 | 3.9225 | 3.9225 | 3.9226 | 3.9226 | 3.9227 |
| | 19 | 30 | 3.9227 | 3.9228 | 3.9228 | 3.9229 | 3.9229 | 3.9230 | 3.9230 | 3.9231 | 3.9231 | 3.9232 |
| | 19 | 40 | 3.9232 | 3.9233 | 3.9233 | 3.9234 | 3.9235 | 3.9235 | 3.9236 | 3.9236 | 3.9237 | 3.9237 |
| | 19 | 50 | 3.9238 | 3.9238 | 3.9239 | 3.9239 | 3.9240 | 3.9240 | 3.9241 | 3.9241 | 3.9242 | 3.9242 |

### Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 2ʰ 20ᵐ | | 0ˢ | 3.9243 | 3.9243 | 3.9244 | 3.9244 | 3.9245 | 3.9245 | 3.9246 | 3.9246 | 3.9247 | 3.9247 |
| | 20 | 10 | 3.9248 | 3.9248 | 3.9249 | 3.9250 | 3.9250 | 3.9251 | 3.9251 | 3.9252 | 3.9252 | 3.9253 |
| | 20 | 20 | 3.9253 | 3.9254 | 3.9254 | 3.9255 | 3.9255 | 3.9256 | 3.9256 | 3.9257 | 3.9257 | 3.9258 |
| | 20 | 30 | 3.9258 | 3.9259 | 3.9259 | 3.9260 | 3.9260 | 3.9261 | 3.9261 | 3.9262 | 3.9262 | 3.9263 |
| | 20 | 40 | 3.9263 | 3.9264 | 3.9264 | 3.9265 | 3.9265 | 3.9266 | 3.9267 | 3.9267 | 3.9268 | 3.9268 |
| | 20 | 50 | 3.9269 | 3.9269 | 3.9270 | 3.9270 | 3.9271 | 3.9271 | 3.9272 | 3.9272 | 3.9273 | 3.9273 |
| 2 | 21 | 0 | 3.9274 | 3.9274 | 3.9275 | 3.9275 | 3.9276 | 3.9276 | 3.9277 | 3.9277 | 3.9278 | 3.9278 |
| | 21 | 10 | 3.9279 | 3.9279 | 3.9280 | 3.9280 | 3.9281 | 3.9281 | 3.9282 | 3.9282 | 3.9283 | 3.9283 |
| | 21 | 20 | 3.9284 | 3.9284 | 3.9285 | 3.9285 | 3.9286 | 3.9287 | 3.9287 | 3.9288 | 3.9288 | 3.9289 |
| | 21 | 30 | 3.9289 | 3.9290 | 3.9290 | 3.9291 | 3.9291 | 3.9292 | 3.9292 | 3.9293 | 3.9293 | 3.9294 |
| | 21 | 40 | 3.9294 | 3.9295 | 3.9295 | 3.9296 | 3.9296 | 3.9297 | 3.9297 | 3.9298 | 3.9298 | 3.9299 |
| | 21 | 50 | 3.9299 | 3.9300 | 3.9300 | 3.9301 | 3.9301 | 3.9302 | 3.9302 | 3.9303 | 3.9303 | 3.9304 |
| 2 | 22 | 0 | 3.9304 | 3.9305 | 3.9305 | 3.9306 | 3.9306 | 3.9307 | 3.9307 | 3.9308 | 3.9308 | 3.9309 |
| | 22 | 10 | 3.9309 | 3.9310 | 3.9311 | 3.9311 | 3.9312 | 3.9312 | 3.9313 | 3.9313 | 3.9314 | 3.9314 |
| | 22 | 20 | 3.9315 | 3.9315 | 3.9316 | 3.9316 | 3.9317 | 3.9317 | 3.9318 | 3.9318 | 3.9319 | 3.9319 |
| | 22 | 30 | 3.9320 | 3.9320 | 3.9321 | 3.9321 | 3.9322 | 3.9322 | 3.9323 | 3.9323 | 3.9324 | 3.9324 |
| | 22 | 40 | 3.9325 | 3.9325 | 3.9326 | 3.9326 | 3.9327 | 3.9327 | 3.9328 | 3.9328 | 3.9329 | 3.9329 |
| | 22 | 50 | 3.9330 | 3.9330 | 3.9331 | 3.9331 | 3.9332 | 3.9332 | 3.9333 | 3.9333 | 3.9334 | 3.9334 |
| 2 | 23 | 0 | 3.9335 | 3.9335 | 3.9336 | 3.9336 | 3.9337 | 3.9337 | 3.9338 | 3.9338 | 3.9339 | 3.9339 |
| | 23 | 10 | 3.9340 | 3.9340 | 3.9341 | 3.9341 | 3.9342 | 3.9342 | 3.9343 | 3.9343 | 3.9344 | 3.9344 |
| | 23 | 20 | 3.9345 | 3.9345 | 3.9346 | 3.9346 | 3.9347 | 3.9348 | 3.9348 | 3.9349 | 3.9349 | 3.9350 |
| | 23 | 30 | 3.9350 | 3.9351 | 3.9351 | 3.9352 | 3.9352 | 3.9353 | 3.9353 | 3.9354 | 3.9354 | 3.9355 |
| | 23 | 40 | 3.9355 | 3.9356 | 3.9356 | 3.9357 | 3.9357 | 3.9358 | 3.9358 | 3.9359 | 3.9359 | 3.9360 |
| | 23 | 50 | 3.9360 | 3.9361 | 3.9361 | 3.9362 | 3.9362 | 3.9363 | 3.9363 | 3.9364 | 3.9364 | 3.9365 |
| 2 | 24 | 0 | 3.9365 | 3.9366 | 3.9366 | 3.9367 | 3.9367 | 3.9368 | 3.9368 | 3.9369 | 3.9369 | 3.9370 |
| | 24 | 10 | 3.9370 | 3.9371 | 3.9371 | 3.9372 | 3.9372 | 3.9373 | 3.9373 | 3.9374 | 3.9374 | 3.9375 |
| | 24 | 20 | 3.9375 | 3.9376 | 3.9376 | 3.9377 | 3.9377 | 3.9378 | 3.9378 | 3.9379 | 3.9379 | 3.9380 |
| | 24 | 30 | 3.9380 | 3.9381 | 3.9381 | 3.9382 | 3.9382 | 3.9383 | 3.9383 | 3.9384 | 3.9384 | 3.9385 |
| | 24 | 40 | 3.9385 | 3.9386 | 3.9386 | 3.9387 | 3.9387 | 3.9388 | 3.9388 | 3.9389 | 3.9389 | 3.9390 |
| | 24 | 50 | 3.9390 | 3.9391 | 3.9391 | 3.9392 | 3.9392 | 3.9393 | 3.9393 | 3.9394 | 3.9394 | 3.9395 |
| 2 | 25 | 0 | 3.9395 | 3.9396 | 3.9396 | 3.9397 | 3.9397 | 3.9398 | 3.9398 | 3.9399 | 3.9399 | 3.9400 |
| | 25 | 10 | 3.9400 | 3.9401 | 3.9401 | 3.9402 | 3.9402 | 3.9403 | 3.9403 | 3.9404 | 3.9404 | 3.9405 |
| | 25 | 20 | 3.9405 | 3.9406 | 3.9406 | 3.9407 | 3.9407 | 3.9408 | 3.9408 | 3.9409 | 3.9409 | 3.9410 |
| | 25 | 30 | 3.9410 | 3.9411 | 3.9411 | 3.9412 | 3.9412 | 3.9413 | 3.9413 | 3.9414 | 3.9414 | 3.9415 |
| | 25 | 40 | 3.9415 | 3.9416 | 3.9416 | 3.9417 | 3.9417 | 3.9418 | 3.9418 | 3.9419 | 3.9419 | 3.9420 |
| | 25 | 50 | 3.9420 | 3.9421 | 3.9421 | 3.9422 | 3.9422 | 3.9423 | 3.9423 | 3.9424 | 3.9424 | 3.9425 |
| 2 | 26 | 0 | 3.9425 | 3.9426 | 3.9426 | 3.9427 | 3.9427 | 3.9428 | 3.9428 | 3.9429 | 3.9429 | 3.9430 |
| | 26 | 10 | 3.9430 | 3.9430 | 3.9431 | 3.9431 | 3.9432 | 3.9432 | 3.9433 | 3.9433 | 3.9434 | 3.9434 |
| | 26 | 20 | 3.9435 | 3.9435 | 3.9436 | 3.9436 | 3.9437 | 3.9437 | 3.9438 | 3.9438 | 3.9439 | 3.9439 |
| | 26 | 30 | 3.9440 | 3.9440 | 3.9441 | 3.9441 | 3.9442 | 3.9442 | 3.9443 | 3.9443 | 3.9444 | 3.9444 |
| | 26 | 40 | 3.9445 | 3.9445 | 3.9446 | 3.9446 | 3.9447 | 3.9447 | 3.9448 | 3.9448 | 3.9449 | 3.9449 |
| | 26 | 50 | 3.9450 | 3.9450 | 3.9451 | 3.9451 | 3.9452 | 3.9452 | 3.9453 | 3.9453 | 3.9454 | 3.9454 |
| 2 | 27 | 0 | 3.9455 | 3.9455 | 3.9456 | 3.9456 | 3.9457 | 3.9457 | 3.9458 | 3.9458 | 3.9459 | 3.9459 |
| | 27 | 10 | 3.9460 | 3.9460 | 3.9461 | 3.9461 | 3.9462 | 3.9462 | 3.9463 | 3.9463 | 3.9464 | 3.9464 |
| | 27 | 20 | 3.9465 | 3.9465 | 3.9466 | 3.9466 | 3.9466 | 3.9467 | 3.9467 | 3.9468 | 3.9468 | 3.9469 |
| | 27 | 30 | 3.9469 | 3.9470 | 3.9470 | 3.9471 | 3.9471 | 3.9472 | 3.9472 | 3.9473 | 3.9473 | 3.9474 |
| | 27 | 40 | 3.9474 | 3.9475 | 3.9475 | 3.9476 | 3.9476 | 3.9477 | 3.9477 | 3.9478 | 3.9478 | 3.9479 |
| | 27 | 50 | 3.9479 | 3.9480 | 3.9480 | 3.9481 | 3.9481 | 3.9482 | 3.9482 | 3.9483 | 3.9483 | 3.9484 |
| 2 | 28 | 0 | 3.9484 | 3.9485 | 3.9485 | 3.9486 | 3.9486 | 3.9487 | 3.9487 | 3.9488 | 3.9488 | 3.9489 |
| | 28 | 10 | 3.9489 | 3.9490 | 3.9490 | 3.9490 | 3.9491 | 3.9491 | 3.9492 | 3.9492 | 3.9493 | 3.9493 |
| | 28 | 20 | 3.9494 | 3.9494 | 3.9495 | 3.9495 | 3.9496 | 3.9496 | 3.9497 | 3.9497 | 3.9498 | 3.9498 |
| | 28 | 30 | 3.9499 | 3.9499 | 3.9500 | 3.9500 | 3.9501 | 3.9501 | 3.9502 | 3.9502 | 3.9503 | 3.9503 |
| | 28 | 40 | 3.9504 | 3.9504 | 3.9505 | 3.9505 | 3.9506 | 3.9506 | 3.9507 | 3.9507 | 3.9508 | 3.9508 |
| | 28 | 50 | 3.9509 | 3.9509 | 3.9509 | 3.9510 | 3.9510 | 3.9511 | 3.9511 | 3.9512 | 3.9512 | 3.9513 |
| 2 | 29 | 0 | 3.9513 | 3.9514 | 3.9514 | 3.9515 | 3.9515 | 3.9516 | 3.9516 | 3.9517 | 3.9517 | 3.9518 |
| | 29 | 10 | 3.9518 | 3.9519 | 3.9519 | 3.9520 | 3.9520 | 3.9521 | 3.9521 | 3.9522 | 3.9522 | 3.9523 |
| | 29 | 20 | 3.9523 | 3.9524 | 3.9524 | 3.9525 | 3.9525 | 3.9526 | 3.9526 | 3.9526 | 3.9527 | 3.9527 |
| | 29 | 30 | 3.9528 | 3.9528 | 3.9529 | 3.9529 | 3.9530 | 3.9530 | 3.9531 | 3.9531 | 3.9532 | 3.9532 |
| | 29 | 40 | 3.9533 | 3.9533 | 3.9534 | 3.9534 | 3.9535 | 3.9435 | 3.9536 | 3.9536 | 3.9537 | 3.9537 |
| | 29 | 50 | 3.9538 | 3.9538 | 3.9539 | 3.9539 | 3.9540 | 3.9540 | 3.9540 | 3.9541 | 3.9541 | 3.9542 |

# APPENDIX V: TABLE IX.

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 2ʰ | 30ᵐ | 0ˢ | 3.9542 | 3.9543 | 3.9543 | 3.9544 | 3.9544 | 3.9545 | 3.9545 | 3.9546 | 3.9546 | 3.9547 |
| | 30 | 10 | 3.9547 | 3.9548 | 3.9548 | 3.9549 | 3.9549 | 3.9550 | 3.9550 | 3.9551 | 3.9551 | 3.9552 |
| | 30 | 20 | 3.9552 | 3.9553 | 3.9553 | 3.9554 | 3.9554 | 3.9554 | 3.9555 | 3.9555 | 3.9556 | 3.9556 |
| | 30 | 30 | 3.9557 | 3.9557 | 3.9558 | 3.9558 | 3.9559 | 3.9559 | 3.9560 | 3.9560 | 3.9561 | 3.9561 |
| | 30 | 40 | 3.9562 | 3.9562 | 3.9563 | 3.9563 | 3.9564 | 3.9564 | 3.9565 | 3.9565 | 3.9566 | 3.9566 |
| | 30 | 50 | 3.9566 | 3.9567 | 3.9567 | 3.9568 | 3.9568 | 3.9569 | 3.9569 | 3.9570 | 3.9570 | 3.9571 |
| 2 | 31 | 0 | 3.9571 | 3.9572 | 3.9572 | 3.9573 | 3.9573 | 3.9574 | 3.9574 | 3.9575 | 3.9575 | 3.9576 |
| | 31 | 10 | 3.9576 | 3.9577 | 3.9577 | 3.9578 | 3.9578 | 3.9578 | 3.9579 | 3.9579 | 3.9580 | 3.9580 |
| | 31 | 20 | 3.9581 | 3.9581 | 3.9582 | 3.9582 | 3.9583 | 3.9583 | 3.9584 | 3.9584 | 3.9585 | 3.9585 |
| | 31 | 30 | 3.9586 | 3.9586 | 3.9587 | 3.9587 | 3.9588 | 3.9588 | 3.9589 | 3.9589 | 3.9589 | 3.9590 |
| | 31 | 40 | 3.9590 | 3.9591 | 3.9591 | 3.9592 | 3.9592 | 3.9593 | 3.9593 | 3.9594 | 3.9594 | 3.9595 |
| | 31 | 50 | 3.9595 | 3.9596 | 3.9596 | 3.9597 | 3.9597 | 3.9598 | 3.9598 | 3.9599 | 3.9599 | 3.9599 |
| 2 | 32 | 0 | 3.9600 | 3.9600 | 3.9601 | 3.9601 | 3.9602 | 3.9602 | 3.9603 | 3.9603 | 3.9604 | 3.9604 |
| | 32 | 10 | 3.9605 | 3.9605 | 3.9606 | 3.9606 | 3.9607 | 3.9607 | 3.9608 | 3.9608 | 3.9609 | 3.9609 |
| | 32 | 20 | 3.9609 | 3.9610 | 3.9610 | 3.9611 | 3.9611 | 3.9612 | 3.9612 | 3.9613 | 3.9613 | 3.9614 |
| | 32 | 30 | 3.9614 | 3.9615 | 3.9615 | 3.9616 | 3.9616 | 3.9617 | 3.9617 | 3.9618 | 3.9618 | 3.9618 |
| | 32 | 40 | 3.9619 | 3.9619 | 3.9620 | 3.9620 | 3.9621 | 3.9621 | 3.9622 | 3.9622 | 3.9623 | 3.9623 |
| | 32 | 50 | 3.9624 | 3.9624 | 3.9625 | 3.9625 | 3.9626 | 3.9626 | 3.9627 | 3.9627 | 3.9627 | 3.9628 |
| 2 | 33 | 0 | 3.9628 | 3.9629 | 3.9629 | 3.9630 | 3.9630 | 3.9631 | 3.9631 | 3.9632 | 3.9632 | 3.9633 |
| | 33 | 10 | 3.9633 | 3.9634 | 3.9634 | 3.9634 | 3.9635 | 3.9635 | 3.9636 | 3.9636 | 3.9637 | 3.9637 |
| | 33 | 20 | 3.9638 | 3.9638 | 3.9639 | 3.9639 | 3.9640 | 3.9640 | 3.9641 | 3.9641 | 3.9642 | 3.9642 |
| | 33 | 30 | 3.9642 | 3.9643 | 3.9643 | 3.9644 | 3.9644 | 3.9645 | 3.9645 | 3.9646 | 3.9646 | 3.9647 |
| | 33 | 40 | 3.9647 | 3.9648 | 3.9648 | 3.9649 | 3.9649 | 3.9650 | 3.9650 | 3.9651 | 3.9651 | 3.9652 |
| | 33 | 50 | 3.9652 | 3.9653 | 3.9653 | 3.9653 | 3.9654 | 3.9654 | 3.9655 | 3.9655 | 3.9656 | 3.9656 |
| 2 | 34 | 0 | 3.9657 | 3.9657 | 3.9658 | 3.9658 | 3.9658 | 3.9659 | 3.9659 | 3.9660 | 3.9660 | 3.9661 |
| | 34 | 10 | 3.9661 | 3.9662 | 3.9662 | 3.9663 | 3.9663 | 3.9664 | 3.9664 | 3.9665 | 3.9665 | 3.9665 |
| | 34 | 20 | 3.9666 | 3.9666 | 3.9667 | 3.9667 | 3.9668 | 3.9668 | 3.9669 | 3.9669 | 3.9670 | 3.9670 |
| | 34 | 30 | 3.9671 | 3.9671 | 3.9672 | 3.9672 | 3.9672 | 3.9673 | 3.9673 | 3.9674 | 3.9674 | 3.9675 |
| | 34 | 40 | 3.9675 | 3.9676 | 3.9676 | 3.9677 | 3.9677 | 3.9678 | 3.9678 | 3.9679 | 3.9679 | 3.9680 |
| | 34 | 50 | 3.9680 | 3.9681 | 3.9681 | 3.9682 | 3.9682 | 3.9682 | 3.9683 | 3.9683 | 3.9684 | 3.9684 |
| 2 | 35 | 0 | 3.9685 | 3.9685 | 3.9686 | 3.9686 | 3.9687 | 3.9687 | 3.9688 | 3.9688 | 3.9689 | 3.9689 |
| | 35 | 10 | 3.9689 | 3.9690 | 3.9690 | 3.9691 | 3.9691 | 3.9692 | 3.9692 | 3.9693 | 3.9693 | 3.9694 |
| | 35 | 20 | 3.9694 | 3.9695 | 3.9695 | 3.9696 | 3.9696 | 3.9696 | 3.9697 | 3.9697 | 3.9698 | 3.9698 |
| | 35 | 30 | 3.9699 | 3.9699 | 3.9700 | 3.9700 | 3.9701 | 3.9701 | 3.9702 | 3.9702 | 3.9703 | 3.9703 |
| | 35 | 40 | 3.9703 | 3.9704 | 3.9704 | 3.9705 | 3.9705 | 3.9706 | 3.9706 | 3.9707 | 3.9707 | 3.9708 |
| | 35 | 50 | 3.9708 | 3.9709 | 3.9709 | 3.9710 | 3.9710 | 3.9710 | 3.9711 | 3.9711 | 3.9712 | 3.9712 |
| 2 | 36 | 0 | 3.9713 | 3.9713 | 3.9714 | 3.9714 | 3.9715 | 3.9715 | 3.9716 | 3.9716 | 3.9716 | 3.9717 |
| | 36 | 10 | 3.9717 | 3.9718 | 3.9718 | 3.9719 | 3.9719 | 3.9720 | 3.9720 | 3.9721 | 3.9721 | 3.9722 |
| | 36 | 20 | 3.9722 | 3.9722 | 3.9723 | 3.9723 | 3.9724 | 3.9724 | 3.9725 | 3.9725 | 3.9726 | 3.9726 |
| | 36 | 30 | 3.9727 | 3.9727 | 3.9728 | 3.9728 | 3.9729 | 3.9729 | 3.9729 | 3.9730 | 3.9730 | 3.9731 |
| | 36 | 40 | 3.9731 | 3.9732 | 3.9732 | 3.9733 | 3.9733 | 3.9734 | 3.9734 | 3.9735 | 3.9735 | 3.9735 |
| | 36 | 50 | 3.9736 | 3.9736 | 3.9737 | 3.9737 | 3.9738 | 3.9738 | 3.9739 | 3.9739 | 3.9740 | 3.9740 |
| 2 | 37 | 0 | 3.9741 | 3.9741 | 3.9741 | 3.9742 | 3.9742 | 3.9743 | 3.9743 | 3.9744 | 3.9744 | 3.9745 |
| | 37 | 10 | 3.9745 | 3.9746 | 3.9746 | 3.9746 | 3.9747 | 3.9747 | 3.9748 | 3.9748 | 3.9749 | 3.9749 |
| | 37 | 20 | 3.9750 | 3.9750 | 3.9751 | 3.9751 | 3.9752 | 3.9752 | 3.9752 | 3.9753 | 3.9753 | 3.9754 |
| | 37 | 30 | 3.9754 | 3.9755 | 3.9755 | 3.9756 | 3.9756 | 3.9757 | 3.9757 | 3.9758 | 3.9758 | 3.9758 |
| | 37 | 40 | 3.9759 | 3.9759 | 3.9760 | 3.9760 | 3.9761 | 3.9761 | 3.9762 | 3.9762 | 3.9763 | 3.9763 |
| | 37 | 50 | 3.9763 | 3.9764 | 3.9764 | 3.9765 | 3.9765 | 3.9766 | 3.9766 | 3.9767 | 3.9767 | 3.9768 |
| 2 | 38 | 0 | 3.9768 | 3.9769 | 3.9769 | 3.9769 | 3.9770 | 3.9770 | 3.9771 | 3.9771 | 3.9772 | 3.9772 |
| | 38 | 10 | 3.9773 | 3.9773 | 3.9774 | 3.9774 | 3.9774 | 3.9775 | 3.9775 | 3.9776 | 3.9776 | 3.9777 |
| | 38 | 20 | 3.9777 | 3.9778 | 3.9778 | 3.9779 | 3.9779 | 3.9779 | 3.9780 | 3.9780 | 3.9781 | 3.9781 |
| | 38 | 30 | 3.9782 | 3.9782 | 3.9783 | 3.9783 | 3.9784 | 3.9784 | 3.9785 | 3.9785 | 3.9785 | 3.9786 |
| | 38 | 40 | 3.9786 | 3.9787 | 3.9787 | 3.9788 | 3.9788 | 3.9789 | 3.9789 | 3.9790 | 3.9790 | 3.9790 |
| | 38 | 50 | 3.9791 | 3.9791 | 3.9792 | 3.9792 | 3.9793 | 3.9793 | 3.9794 | 3.9794 | 3.9795 | 3.9795 |
| 2 | 39 | 0 | 3.9795 | 3.9796 | 3.9796 | 3.9797 | 3.9797 | 3.9798 | 3.9798 | 3.9799 | 3.9799 | 3.9800 |
| | 39 | 10 | 3.9800 | 3.9800 | 3.9801 | 3.9801 | 3.9802 | 3.9802 | 3.9803 | 3.9803 | 3.9804 | 3.9804 |
| | 39 | 20 | 3.9805 | 3.9805 | 3.9805 | 3.9806 | 3.9806 | 3.9807 | 3.9807 | 3.9808 | 3.9808 | 3.9809 |
| | 39 | 30 | 3.9809 | 3.9810 | 3.9810 | 3.9810 | 3.9811 | 3.9811 | 3.9812 | 3.9812 | 3.9813 | 3.9813 |
| | 39 | 40 | 3.9814 | 3.9814 | 3.9815 | 3.9815 | 3.9815 | 3.9816 | 3.9816 | 3.9817 | 3.9817 | 3.9818 |
| | 39 | 50 | 3.9818 | 3.9819 | 3.9819 | 3.9819 | 3.9820 | 3.9820 | 3.9821 | 3.9821 | 3.9822 | 3.9822 |

Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | ′ | ″ | | | | | | | | | | |
| 2ʰ 40ᵐ | | 0ˢ | 3.9823 | 3.9823 | 3.9824 | 3.9824 | 3.9825 | 3.9825 | 3.9825 | 3.9826 | 3.9826 | 3.9827 |
| | 40 | 10 | 3.9827 | 3.9828 | 3.9828 | 3.9829 | 3.9829 | 3.9829 | 3.9830 | 3.9830 | 3.9831 | 3.9831 |
| | 40 | 20 | 3.9832 | 3.9832 | 3.9833 | 3.9833 | 3.9834 | 3.9834 | 3.9834 | 3.9835 | 3.9835 | 3.9836 |
| | 40 | 30 | 3.9836 | 3.9837 | 3.9837 | 3.9838 | 3.9838 | 3.9839 | 3.9839 | 3.9839 | 3.9840 | 3.9840 |
| | 40 | 40 | 3.9841 | 3.9841 | 3.9842 | 3.9842 | 3.9843 | 3.9843 | 3.9843 | 3.9844 | 3.9844 | 3.9845 |
| | 40 | 50 | 3.9845 | 3.9846 | 3.9846 | 3.9847 | 3.9847 | 3.9848 | 3.9848 | 3.9848 | 3.9849 | 3.9849 |
| 2 | 41 | 0 | 3.9850 | 3.9850 | 3.9851 | 3.9851 | 3.9852 | 3.9852 | 3.9852 | 3.9853 | 3.9853 | 3.9854 |
| | 41 | 10 | 3.9854 | 3.9855 | 3.9855 | 3.9856 | 3.9856 | 3.9857 | 3.9857 | 3.9857 | 3.9858 | 3.9858 |
| | 41 | 20 | 3.9859 | 3.9859 | 3.9860 | 3.9860 | 3.9861 | 3.9861 | 3.9861 | 3.9862 | 3.9862 | 3.9863 |
| | 41 | 30 | 3.9863 | 3.9864 | 3.9864 | 3.9865 | 3.9865 | 3.9865 | 3.9866 | 3.9866 | 3.9867 | 3.9867 |
| | 41 | 40 | 3.9868 | 3.9868 | 3.9869 | 3.9869 | 3.9870 | 3.9870 | 3.9870 | 3.9871 | 3.9871 | 3.9872 |
| | 41 | 50 | 3.9872 | 3.9873 | 3.9873 | 3.9874 | 3.9874 | 3.9874 | 3.9875 | 3.9875 | 3.9876 | 3.9876 |
| 2 | 42 | 0 | 3.9877 | 3.9877 | 3.9878 | 3.9878 | 3.9878 | 3.9879 | 3.9879 | 3.9880 | 3.9880 | 3.9881 |
| | 42 | 10 | 3.9881 | 3.9882 | 3.9882 | 3.9882 | 3.9883 | 3.9883 | 3.9884 | 3.9884 | 3.9885 | 3.9885 |
| | 42 | 20 | 3.9886 | 3.9886 | 3.9886 | 3.9887 | 3.9887 | 3.9888 | 3.9888 | 3.9889 | 3.9889 | 3.9890 |
| | 42 | 30 | 3.9890 | 3.9890 | 3.9891 | 3.9891 | 3.9892 | 3.9892 | 3.9893 | 3.9893 | 3.9894 | 3.9894 |
| | 42 | 40 | 3.9894 | 3.9895 | 3.9895 | 3.9896 | 3.9896 | 3.9897 | 3.9897 | 3.9898 | 3.9898 | 3.9898 |
| | 42 | 50 | 3.9899 | 3.9899 | 3.9900 | 3.9900 | 3.9901 | 3.9901 | 3.9902 | 3.9902 | 3.9903 | 3.9903 |
| 2 | 43 | 0 | 3.9903 | 3.9904 | 3.9904 | 3.9905 | 3.9905 | 3.9906 | 3.9906 | 3.9906 | 3.9907 | 3.9907 |
| | 43 | 10 | 3.9908 | 3.9908 | 3.9909 | 3.9909 | 3.9910 | 3.9910 | 3.9910 | 3.9911 | 3.9911 | 3.9912 |
| | 43 | 20 | 3.9912 | 3.9913 | 3.9913 | 3.9914 | 3.9914 | 3.9914 | 3.9915 | 3.9915 | 3.9916 | 3.9916 |
| | 43 | 30 | 3.9917 | 3.9917 | 3.9918 | 3.9918 | 3.9918 | 3.9919 | 3.9919 | 3.9920 | 3.9920 | 3.9921 |
| | 43 | 40 | 3.9921 | 3.9922 | 3.9922 | 3.9922 | 3.9923 | 3.9923 | 3.9924 | 3.9924 | 3.9925 | 3.9925 |
| | 43 | 50 | 3.9926 | 3.9926 | 3.9926 | 3.9927 | 3.9927 | 3.9928 | 3.9928 | 3.9929 | 3.9929 | 3.9930 |
| 2 | 44 | 0 | 3.9930 | 3.9930 | 3.9931 | 3.9931 | 3.9932 | 3.9932 | 3.9933 | 3.9933 | 3.9933 | 3.9934 |
| | 44 | 10 | 3.9934 | 3.9935 | 3.9935 | 3.9936 | 3.9936 | 3.9937 | 3.9937 | 3.9937 | 3.9938 | 3.9938 |
| | 44 | 20 | 3.9939 | 3.9939 | 3.9940 | 3.9940 | 3.9941 | 3.9941 | 3.9941 | 3.9942 | 3.9942 | 3.9943 |
| | 44 | 30 | 3.9943 | 3.9944 | 3.9944 | 3.9944 | 3.9945 | 3.9945 | 3.9946 | 3.9946 | 3.9947 | 3.9947 |
| | 44 | 40 | 3.9948 | 3.9948 | 3.9948 | 3.9949 | 3.9949 | 3.9950 | 3.9950 | 3.9951 | 3.9951 | 3.9952 |
| | 44 | 50 | 3.9952 | 3.9952 | 3.9953 | 3.9953 | 3.9954 | 3.9954 | 3.9955 | 3.9955 | 3.9955 | 3.9956 |
| 2 | 45 | 0 | 3.9956 | 3.9957 | 3.9957 | 3.9958 | 3.9958 | 3.9959 | 3.9959 | 3.9959 | 3.9960 | 3.9960 |
| | 45 | 10 | 3.9961 | 3.9961 | 3.9962 | 3.9962 | 3.9962 | 3.9963 | 3.9963 | 3.9964 | 3.9964 | 3.9965 |
| | 45 | 20 | 3.9965 | 3.9966 | 3.9966 | 3.9966 | 3.9967 | 3.9967 | 3.9968 | 3.9968 | 3.9969 | 3.9969 |
| | 45 | 30 | 3.9969 | 3.9970 | 3.9970 | 3.9971 | 3.9971 | 3.9972 | 3.9972 | 3.9973 | 3.9973 | 3.9973 |
| | 45 | 40 | 3.9974 | 3.9974 | 3.9975 | 3.9975 | 3.9976 | 3.9976 | 3.9976 | 3.9977 | 3.9977 | 3.9978 |
| | 45 | 50 | 3.9978 | 3.9979 | 3.9979 | 3.9980 | 3.9980 | 3.9980 | 3.9981 | 3.9981 | 3.9982 | 3.9982 |
| 2 | 46 | 0 | 3.9983 | 3.9983 | 3.9983 | 3.9984 | 3.9984 | 3.9985 | 3.9985 | 3.9986 | 3.9986 | 3.9987 |
| | 46 | 10 | 3.9987 | 3.9987 | 3.9988 | 3.9988 | 3.9989 | 3.9989 | 3.9990 | 3.9990 | 3.9990 | 3.9991 |
| | 46 | 20 | 3.9991 | 3.9992 | 3.9992 | 3.9993 | 3.9993 | 3.9993 | 3.9994 | 3.9994 | 3.9995 | 3.9995 |
| | 46 | 30 | 3.9996 | 3.9996 | 3.9996 | 3.9997 | 3.9997 | 3.9997 | 3.9998 | 3.9999 | 3.9999 | 4.0000 |
| | 46 | 40 | 4.0000 | 4.0000 | 4.0001 | 4.0001 | 4.0002 | 4.0002 | 4.0003 | 4.0003 | 4.0003 | 4.0004 |
| | 46 | 50 | 4.0004 | 4.0005 | 4.0005 | 4.0006 | 4.0006 | 4.0007 | 4.0007 | 4.0007 | 4.0008 | 4.0008 |
| 2 | 47 | 0 | 4.0009 | 4.0009 | 4.0010 | 4.0010 | 4.0010 | 4.0011 | 4.0011 | 4.0012 | 4.0012 | 4.0013 |
| | 47 | 10 | 4.0013 | 4.0013 | 4.0014 | 4.0014 | 4.0015 | 4.0015 | 4.0016 | 4.0016 | 4.0016 | 4.0017 |
| | 47 | 20 | 4.0017 | 4.0018 | 4.0018 | 4.0019 | 4.0019 | 4.0019 | 4.0020 | 4.0020 | 4.0021 | 4.0021 |
| | 47 | 30 | 4.0022 | 4.0022 | 4.0023 | 4.0023 | 4.0023 | 4.0024 | 4.0024 | 4.0025 | 4.0025 | 4.0026 |
| | 47 | 40 | 4.0026 | 4.0026 | 4.0027 | 4.0027 | 4.0028 | 4.0028 | 4.0029 | 4.0029 | 4.0029 | 4.0030 |
| | 47 | 50 | 4.0030 | 4.0031 | 4.0031 | 4.0032 | 4.0032 | 4.0032 | 4.0033 | 4.0033 | 4.0034 | 4.0034 |
| 2 | 48 | 0 | 4.0035 | 4.0035 | 4.0036 | 4.0036 | 4.0036 | 4.0037 | 4.0037 | 4.0038 | 4.0038 | 4.0038 |
| | 48 | 10 | 4.0039 | 4.0039 | 4.0040 | 4.0040 | 4.0041 | 4.0041 | 4.0041 | 4.0042 | 4.0042 | 4.0043 |
| | 48 | 20 | 4.0043 | 4.0044 | 4.0044 | 4.0045 | 4.0045 | 4.0045 | 4.0046 | 4.0046 | 4.0047 | 4.0047 |
| | 48 | 30 | 4.0048 | 4.0048 | 4.0048 | 4.0049 | 4.0049 | 4.0050 | 4.0050 | 4.0051 | 4.0051 | 4.0051 |
| | 48 | 40 | 4.0052 | 4.0052 | 4.0053 | 4.0053 | 4.0054 | 4.0054 | 4.0054 | 4.0055 | 4.0055 | 4.0056 |
| | 48 | 50 | 4.0056 | 4.0057 | 4.0057 | 4.0057 | 4.0058 | 4.0058 | 4.0059 | 4.0059 | 4.0060 | 4.0060 |
| 2 | 49 | 0 | 4.0060 | 4.0061 | 4.0061 | 4.0062 | 4.0062 | 4.0063 | 4.0063 | 4.0063 | 4.0064 | 4.0064 |
| | 49 | 10 | 4.0065 | 4.0065 | 4.0066 | 4.0066 | 4.0066 | 4.0067 | 4.0067 | 4.0068 | 4.0068 | 4.0069 |
| | 49 | 20 | 4.0069 | 4.0069 | 4.0070 | 4.0070 | 4.0071 | 4.0071 | 4.0072 | 4.0072 | 4.0072 | 4.0073 |
| | 49 | 30 | 4.0073 | 4.0074 | 4.0074 | 4.0074 | 4.0075 | 4.0075 | 4.0076 | 4.0076 | 4.0077 | 4.0077 |
| | 49 | 40 | 4.0077 | 4.0078 | 4.0078 | 4.0079 | 4.0079 | 4.0080 | 4.0080 | 4.0080 | 4.0081 | 4.0081 |
| | 49 | 50 | 4.0082 | 4.0082 | 4.0083 | 4.0083 | 4.0083 | 4.0084 | 4.0084 | 4.0085 | 4.0085 | 4.0086 |

# APPENDIX V: TABLE IX.

## Logarithms of Small Arcs in Space or Time.

| Arc. | | | 0″ | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °<br>2ʰ 50ᵐ | ′<br>50 | ″<br>0ˢ | 4.0086 | 4.0086 | 4.0087 | 4.0087 | 4.0088 | 4.0088 | 4.0089 | 4.0089 | 4.0089 | 4.0090 |
| | 50 | 10 | 4.0090 | 4.0091 | 4.0091 | 4.0092 | 4.0092 | 4.0092 | 4.0093 | 4.0093 | 4.0094 | 4.0094 |
| | 50 | 20 | 4.0095 | 4.0095 | 4.0095 | 4.0096 | 4.0096 | 4.0097 | 4.0097 | 4.0097 | 4.0098 | 4.0098 |
| | 50 | 30 | 4.0099 | 4.0099 | 4.0100 | 4.0100 | 4.0100 | 4.0101 | 4.0101 | 4.0102 | 4.0102 | 4.0103 |
| | 50 | 40 | 4.0103 | 4.0103 | 4.0104 | 4.0104 | 4.0105 | 4.0105 | 4.0106 | 4.0106 | 4.0106 | 4.0107 |
| | 50 | 50 | 4.0107 | 4.0108 | 4.0108 | 4.0109 | 4.0109 | 4.0109 | 4.0110 | 4.0110 | 4.0111 | 4.0111 |
| 2 | 51 | 0 | 4.0111 | 4.0112 | 4.0112 | 4.0113 | 4.0113 | 4.0114 | 4.0114 | 4.0114 | 4.0115 | 4.0115 |
| | 51 | 10 | 4.0116 | 4.0116 | 4.0117 | 4.0117 | 4.0117 | 4.0118 | 4.0118 | 4.0119 | 4.0119 | 4.0120 |
| | 51 | 20 | 4.0120 | 4.0120 | 4.0121 | 4.0121 | 4.0122 | 4.0122 | 4.0122 | 4.0123 | 4.0123 | 4.0124 |
| | 51 | 30 | 4.0124 | 4.0125 | 4.0125 | 4.0125 | 4.0126 | 4.0126 | 4.0127 | 4.0127 | 4.0128 | 4.0128 |
| | 51 | 40 | 4.0128 | 4.0129 | 4.0129 | 4.0130 | 4.0130 | 4.0130 | 4.0131 | 4.0131 | 4.0132 | 4.0132 |
| | 51 | 50 | 4.0133 | 4.0133 | 4.0133 | 4.0134 | 4.0134 | 4.0135 | 4.0135 | 4.0136 | 4.0136 | 4.0136 |
| 2 | 52 | 0 | 4.0137 | 4.0137 | 4.0138 | 4.0138 | 4.0138 | 4.0139 | 4.0139 | 4.0140 | 4.0140 | 4.0141 |
| | 52 | 10 | 4.0141 | 4.0141 | 4.0142 | 4.0142 | 4.0143 | 4.0143 | 4.0144 | 4.0144 | 4.0144 | 4.0145 |
| | 52 | 20 | 4.0145 | 4.0146 | 4.0146 | 4.0146 | 4.0147 | 4.0147 | 4.0148 | 4.0148 | 4.0149 | 4.0149 |
| | 52 | 30 | 4.0149 | 4.0150 | 4.0150 | 4.0151 | 4.0151 | 4.0152 | 4.0152 | 4.0153 | 4.0153 | 4.0153 |
| | 52 | 40 | 4.0154 | 4.0154 | 4.0154 | 4.0155 | 4.0155 | 4.0156 | 4.0156 | 4.0157 | 4.0157 | 4.0157 |
| | 52 | 50 | 4.0158 | 4.0158 | 4.0159 | 4.0159 | 4.0159 | 4.0160 | 4.0160 | 4.0161 | 4.0161 | 4.0162 |
| 2 | 53 | 0 | 4.0162 | 4.0162 | 4.0163 | 4.0163 | 4.0164 | 4.0164 | 4.0164 | 4.0165 | 4.0165 | 4.0166 |
| | 53 | 10 | 4.0166 | 4.0167 | 4.0167 | 4.0167 | 4.0168 | 4.0168 | 4.0169 | 4.0169 | 4.0169 | 4.0170 |
| | 53 | 20 | 4.0170 | 4.0171 | 4.0171 | 4.0172 | 4.0172 | 4.0172 | 4.0173 | 4.0173 | 4.0174 | 4.0174 |
| | 53 | 30 | 4.0175 | 4.0175 | 4.0175 | 4.0176 | 4.0176 | 4.0177 | 4.0177 | 4.0177 | 4.0178 | 4.0178 |
| | 53 | 40 | 4.0179 | 4.0179 | 4.0180 | 4.0180 | 4.0180 | 4.0181 | 4.0181 | 4.0182 | 4.0182 | 4.0182 |
| | 53 | 50 | 4.0183 | 4.0183 | 4.0184 | 4.0184 | 4.0185 | 4.0185 | 4.0185 | 4.0186 | 4.0186 | 4.0187 |
| 2 | 54 | 0 | 4.0187 | 4.0187 | 4.0188 | 4.0188 | 4.0189 | 4.0189 | 4.0190 | 4.0190 | 4.0190 | 4.0191 |
| | 54 | 10 | 4.0191 | 4.0192 | 4.0192 | 4.0192 | 4.0193 | 4.0193 | 4.0194 | 4.0194 | 4.0194 | 4.0195 |
| | 54 | 20 | 4.0195 | 4.0196 | 4.0196 | 4.0197 | 4.0197 | 4.0197 | 4.0198 | 4.0198 | 4.0199 | 4.0199 |
| | 54 | 30 | 4.0199 | 4.0200 | 4.0200 | 4.0201 | 4.0201 | 4.0202 | 4.0202 | 4.0202 | 4.0203 | 4.0203 |
| | 54 | 40 | 4.0204 | 4.0204 | 4.0204 | 4.0205 | 4.0205 | 4.0206 | 4.0206 | 4.0207 | 4.0207 | 4.0207 |
| | 54 | 50 | 4.0208 | 4.0208 | 4.0209 | 4.0209 | 4.0209 | 4.0210 | 4.0210 | 4.0211 | 4.0211 | 4.0211 |
| 2 | 55 | 0 | 4.0212 | 4.0212 | 4.0213 | 4.0213 | 4.0214 | 4.0214 | 4.0214 | 4.0215 | 4.0215 | 4.0216 |
| | 55 | 10 | 4.0216 | 4.0216 | 4.0217 | 4.0217 | 4.0218 | 4.0218 | 4.0219 | 4.0219 | 4.0219 | 4.0220 |
| | 55 | 20 | 4.0220 | 4.0221 | 4.0221 | 4.0221 | 4.0222 | 4.0222 | 4.0223 | 4.0223 | 4.0223 | 4.0224 |
| | 55 | 30 | 4.0224 | 4.0225 | 4.0225 | 4.0225 | 4.0226 | 4.0226 | 4.0227 | 4.0227 | 4.0228 | 4.0228 |
| | 55 | 40 | 4.0228 | 4.0229 | 4.0229 | 4.0230 | 4.0230 | 4.0230 | 4.0231 | 4.0231 | 4.0232 | 4.0232 |
| | 55 | 50 | 4.0233 | 4.0233 | 4.0233 | 4.0234 | 4.0234 | 4.0235 | 4.0235 | 4.0235 | 4.0236 | 4.0236 |
| 2 | 56 | 0 | 4.0237 | 4.0237 | 4.0237 | 4.0238 | 4.0238 | 4.0239 | 4.0239 | 4.0240 | 4.0240 | 4.0240 |
| | 56 | 10 | 4.0241 | 4.0241 | 4.0242 | 4.0242 | 4.0242 | 4.0243 | 4.0243 | 4.0244 | 4.0244 | 4.0244 |
| | 56 | 20 | 4.0245 | 4.0245 | 4.0246 | 4.0246 | 4.0246 | 4.0247 | 4.0247 | 4.0248 | 4.0248 | 4.0249 |
| | 56 | 30 | 4.0249 | 4.0249 | 4.0250 | 4.0250 | 4.0251 | 4.0251 | 4.0251 | 4.0252 | 4.0252 | 4.0253 |
| | 56 | 40 | 4.0253 | 4.0253 | 4.0254 | 4.0254 | 4.0255 | 4.0255 | 4.0256 | 4.0256 | 4.0256 | 4.0257 |
| | 56 | 50 | 4.0257 | 4.0258 | 4.0258 | 4.0258 | 4.0259 | 4.0259 | 4.0260 | 4.0260 | 4.0260 | 4.0261 |
| 2 | 57 | 0 | 4.0261 | 4.0262 | 4.0262 | 4.0262 | 4.0263 | 4.0263 | 4.0264 | 4.0264 | 4.0265 | 4.0265 |
| | 57 | 10 | 4.0265 | 4.0266 | 4.0266 | 4.0267 | 4.0267 | 4.0267 | 4.0268 | 4.0268 | 4.0269 | 4.0269 |
| | 57 | 20 | 4.0269 | 4.0270 | 4.0270 | 4.0271 | 4.0271 | 4.0271 | 4.0272 | 4.0272 | 4.0273 | 4.0273 |
| | 57 | 30 | 4.0273 | 4.0274 | 4.0274 | 4.0275 | 4.0275 | 4.0276 | 4.0276 | 4.0276 | 4.0277 | 4.0277 |
| | 57 | 40 | 4.0278 | 4.0278 | 4.0278 | 4.0279 | 4.0279 | 4.0280 | 4.0280 | 4.0280 | 4.0281 | 4.0281 |
| | 57 | 50 | 4.0282 | 4.0282 | 4.0282 | 4.0283 | 4.0283 | 4.0284 | 4.0284 | 4.0284 | 4.0285 | 4.0285 |
| 2 | 58 | 0 | 4.0286 | 4.0286 | 4.0287 | 4.0287 | 4.0287 | 4.0288 | 4.0288 | 4.0289 | 4.0289 | 4.0289 |
| | 58 | 10 | 4.0290 | 4.0290 | 4.0291 | 4.0291 | 4.0291 | 4.0292 | 4.0292 | 4.0293 | 4.0293 | 4.0293 |
| | 58 | 20 | 4.0294 | 4.0294 | 4.0295 | 4.0295 | 4.0295 | 4.0296 | 4.0296 | 4.0297 | 4.0297 | 4.0297 |
| | 58 | 30 | 4.0298 | 4.0298 | 4.0299 | 4.0299 | 4.0300 | 4.0300 | 4.0300 | 4.0301 | 4.0301 | 4.0302 |
| | 58 | 40 | 4.0302 | 4.0302 | 4.0303 | 4.0303 | 4.0304 | 4.0304 | 4.0304 | 4.0305 | 4.0305 | 4.0306 |
| | 58 | 50 | 4.0306 | 4.0306 | 4.0307 | 4.0307 | 4.0307 | 4.0308 | 4.0308 | 4.0308 | 4.0309 | 4.0309 | 4.0310 |
| 2 | 59 | 0 | 4.0310 | 4.0310 | 4.0311 | 4.0311 | 4.0312 | 4.0312 | 4.0312 | 4.0313 | 4.0313 | 4.0314 |
| | 59 | 10 | 4.0314 | 4.0314 | 4.0315 | 4.0315 | 4.0316 | 4.0316 | 4.0317 | 4.0317 | 4.0317 | 4.0318 |
| | 59 | 20 | 4.0318 | 4.0319 | 4.0319 | 4.0319 | 4.0320 | 4.0320 | 4.0321 | 4.0321 | 4.0321 | 4.0322 |
| | 59 | 30 | 4.0322 | 4.0323 | 4.0323 | 4.0323 | 4.0324 | 4.0324 | 4.0325 | 4.0325 | 4.0325 | 4.0326 |
| | 59 | 40 | 4.0326 | 4.0327 | 4.0327 | 4.0327 | 4.0328 | 4.0328 | 4.0329 | 4.0329 | 4.0329 | 4.0330 |
| | 59 | 50 | 4.0330 | 4.0331 | 4.0331 | 4.0331 | 4.0332 | 4.0332 | 4.0333 | 4.0333 | 4.0333 | 4.0334 |

Table showing the correction required, on account of Second Differences of the Moon's Motion, in Finding the Greenwich Time corresponding to a Corrected Lunar Distance.

| Approximate interval. | | Difference of the proportional logarithms in the Ephemeris. | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 |
| h. m. | h. m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. |
| 0 0 | 3 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 10 | 2 50 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 0 20 | 2 40 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| 0 30 | 2 30 | 0 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 |
| 0 40 | 2 20 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 |
| 0 50 | 2 10 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 |
| 1 0 | 2 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 |
| 1 10 | 1 50 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | 10 | 11 |
| 1 20 | 1 40 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 10 | 11 |
| 1 30 | 1 30 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 11 |

| Approximate interval. | | Difference of the proportional logarithms in the Ephemeris. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 38 | 40 | 42 | 44 | 46 | 48 | 50 | 52 | 54 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | 70 |
| h. m. | h. m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. |
| 0 0 | 3 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 10 | 2 50 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 |
| 0 20 | 2 40 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 |
| 0 30 | 2 30 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 12 |
| 0 40 | 2 20 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 15 | 15 |
| 0 50 | 2 10 | 9 | 10 | 10 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 17 | 17 |
| 1 0 | 2 0 | 10 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 19 |
| 1 10 | 1 50 | 11 | 12 | 12 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 21 |
| 1 20 | 1 40 | 12 | 12 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 20 | 21 | 21 |
| 1 30 | 1 30 | 12 | 12 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 19 | 20 | 21 | 21 | 22 |

| Approximate interval. | | Difference of the proportional logarithms in the Ephemeris. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 72 | 74 | 76 | 78 | 80 | 82 | 84 | 86 | 88 | 90 | 92 | 94 | 96 | 98 | 100 | 102 | 104 |
| h. m. | h. m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. |
| 0 0 | 3 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 10 | 2 50 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 |
| 0 20 | 2 40 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 13 | 13 |
| 0 30 | 2 30 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 17 | 18 | 18 |
| 0 40 | 2 20 | 16 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 |
| 0 50 | 2 10 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 26 | 26 |
| 1 0 | 2 0 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 38 | 28 | 29 |
| 1 10 | 1 50 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 30 | 30 | 31 |
| 1 20 | 1 40 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 29 | 30 | 31 | 31 | 32 |
| 1 30 | 1 30 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 31 | 31 | 32 |

| Approximate interval. | | Difference of the proportional logarithms in the Ephemeris. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 106 | 108 | 110 | 112 | 114 | 116 | 118 | 120 | 122 | 124 | 126 | 128 | 130 | 132 | 134 | 136 | 138 |
| h. m. | h. m. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. | s. |
| 0 0 | 3 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 10 | 2 50 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 |
| 0 20 | 2 40 | 13 | 13 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 17 | 17 |
| 0 30 | 2 30 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 24 | 24 |
| 0 40 | 2 20 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 30 |
| 0 50 | 2 10 | 26 | 27 | 27 | 28 | 29 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 |
| 1 0 | 2 0 | 29 | 30 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 38 |
| 1 10 | 1 50 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 38 | 39 | 40 | 40 | 41 |
| 1 20 | 1 40 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 38 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 42 |
| 1 30 | 1 30 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 37 | 38 | 38 | 39 | 39 | 40 | 40 | 41 | 42 | 43 |

The correction is to be *added* to the approximate Greenwich time when the proportional logarithms in the Ephemeris are *decreasing*, and *subtracted* when they are *increasing*.

# APPENDIX V: TABLE XI.

For finding the value of N for Correcting Lunar Distances for the Compression of the Earth.

### Table XI A, giving 1st part of N.

| App. dist. | Moon's declination. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | 0° | 3° | 6° | 9° | 12° | 15° | 18° | 21° | 24° | 27° | 30° |
| | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 20 | −0 | 3 | 6 | 10 | 13 | 16 | 19 | 22 | 25 | 28 | 31 |
| 22 | 0 | 3 | 6 | 9 | 12 | 14 | 17 | 20 | 23 | 25 | 28 |
| 24 | 0 | 3 | 5 | 8 | 11 | 13 | 16 | 18 | 21 | 23 | 25 |
| 26 | 0 | 2 | 5 | 7 | 10 | 12 | 14 | 17 | 19 | 21 | 23 |
| 28 | 0 | 2 | 4 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 |
| 30 | −0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| 32 | 0 | 2 | 4 | 6 | 8 | 9 | 11 | 13 | 15 | 16 | 18 |
| 34 | 0 | 2 | 4 | 5 | 7 | 9 | 10 | 12 | 14 | 15 | 17 |
| 36 | 0 | 2 | 3 | 5 | 7 | 8 | 10 | 11 | 13 | 14 | 16 |
| 38 | 0 | 2 | 3 | 5 | 6 | 8 | 9 | 10 | 12 | 13 | 14 |
| 40 | −0 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 12 | 13 |
| 42 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 13 |
| 44 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 |
| 46 | 0 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 48 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 50 | −0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 52 | 0 | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 9 |
| 54 | 0 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 7 | 8 |
| 56 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 |
| 58 | 0 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 |
| 60 | −0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 |
| 62 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 |
| 64 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 66 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 |
| 68 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 70 | −0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 |
| 72 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 4 |
| 74 | 0 | 0 | 1 | 1 | 1· | 2 | 2 | 2 | 3 | 3 | 3 |
| 76 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| 78 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 80 | −0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| 82 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| 84 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 86 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 88 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90 | −0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 92 | +0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 96 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 98 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| 100 | +0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| 102 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 104 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| 106 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| 108 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 |
| 110 | +0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 |
| 112 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 114 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 |
| 116 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 118 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 |
| 120 | +0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 |
| 122 | 0 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 |
| 124 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 |
| 126 | 0 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 7 | 8 |
| 128 | 0 | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 9 |
| 130 | +0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

### Table XI B, giving 2d part of N.

| App. dist. | Other body's declination. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | 0° | 3° | 6° | 9° | 12° | 15° | 18° | 21° | 24° | 27° | 30° |
| | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 20 | +0 | 3 | 7 | 10 | 14 | 17 | 20 | 24 | 27 | 30 | 33 |
| 22 | 0 | 3 | 6 | 9 | 13 | 16 | 19 | 22 | 25 | 27 | 30 |
| 24 | 0 | 3 | 6 | 9 | 12 | 14 | 17 | 20 | 23 | 25 | 28 |
| 26 | 0 | 3 | 5 | 8 | 11 | 13 | 16 | 18 | 21 | 23 | 26 |
| 28 | 0 | 3 | 5 | 8 | 10 | 12 | 15 | 17 | 20 | 22 | 24 |
| 30 | +0 | 2 | 5 | 7 | 9 | 12 | 14 | 16 | 18 | 21 | 23 |
| 32 | 0 | 2 | 4 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 |
| 34 | 0 | 2 | 4 | 6 | 8 | 11 | 13 | 15 | 16 | 18 | 20 |
| 36 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 17 | 19 |
| 38 | 0 | 2 | 4 | 6 | 8 | 10 | 11 | 13 | 15 | 17 | 18 |
| 40 | +0 | 2 | 4 | 6 | 7 | 9 | 11 | 13 | 14 | 16 | 18 |
| 42 | 0 | 2 | 4 | 5 | 7 | 9 | 10 | 12 | 14 | 15 | 17 |
| 44 | 0 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 | 16 |
| 46 | 0 | 2 | 3 | 5 | 6 | 8 | 10 | 11 | 13 | 14 | 16 |
| 48 | 0 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 14 | 15 |
| 50 | +0 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 13 | 15 |
| 52 | 0 | 2 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 | 14 |
| 54 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 11 | 13 | 14 |
| 56 | 0 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 12 | 14 |
| 58 | 0 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 12 | 13 |
| 60 | +0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 11 | 12 | 13 |
| 62 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 12 | 13 |
| 64 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 13 |
| 66 | 0 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 |
| 68 | 0 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 |
| 70 | +0 | 1 | 3 | 4 | 5 | 6 | 7 | 9 | 10 | 11 | 12 |
| 72 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 9 | 10 | 11 | 12 |
| 74 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 |
| 76 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| 78 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| 80 | +0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 82 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 84 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 86 | 0 | 1 | 2 | 4 | 5 | 6 | ·7 | 8 | 9 | 10 | 11 |
| 88 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 90 | +0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 92 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 94 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 96 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ·11 |
| 98 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 100 | +0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 102 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| 104 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 |
| 106 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 |
| 108 | 0 | 1· | 2 | 4 | 5 | 6 | 7 | 9 | 10 | 11 | 12 |
| 110 | +0 | 1 | 3 | 4 | 5 | 6 | 7 | 9 | 10 | 11 | 12 |
| 112 | 0 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 |
| 114 | 0 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 12 |
| 116 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 13 |
| 118 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 12 | 13 |
| 120 | +0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 11 | 12 | 13 |
| 122 | 0 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 12 | 13 |
| 124 | 0 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 12 | 14 |
| 126 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 11 | 13 | 14 |
| 128 | 0 | 2 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 | 14 |
| 130 | +0 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 13 | 15 |

The signs in the 0° column apply to all the numbers in the same line, and are to be used when the declination is *North.*.
When the declination is *South* change the sign + to − and − to +.

# INDEX TO PART I.

333

# PART II.

## TABLES.

# CONTENTS OF PART II.

# EXPLANATION OF THE TABLES.

### TABLES 1, 2: TRAVERSE TABLES.

Tables 1 and 2 were originally calculated by the natural sines taken from the fourth edition of Sherwin's Logarithms, which were previously examined, by differences; when the proof sheets of the first edition were examined the numbers were again calculated by the natural sines in the second edition of Hutton's Logarithms; and if any difference was found, the numbers were calculated a third time by Taylor's Logarithms.

The first table contains the difference of latitude and departure corresponding to distances not exceeding 300 miles, and for courses to every quarter point of the compass. Table 2 is of the same nature, but for courses consisting of whole degrees; it was originally of the same extent as Table 1, but has been extended to include distances up to 600 miles. The manner of using these tables is particularly explained under the different problems of Plane, Middle Latitude, and Mercator Sailing in Chapter V.

The tables may be employed in the solution of any right triangle.

### TABLE 3: MERIDIONAL PARTS.

This table contains the meridional parts, or increased latitudes, for every degree and minute to 80°, calculated by the following formula:

$$m = \frac{a}{M} \log \tan\left(45° + \frac{L}{2}\right) - a\left(e^2 \sin L + \tfrac{1}{3} e^4 \sin^3 L + \tfrac{1}{5} e^6 \sin^5 L + \quad \ldots \quad \right),$$

in which

the Equatorial radius $a = \dfrac{10800'}{\pi} = 3437'.74677$ (log 3.5362739);

M, the modulus of common logarithms = 0.4342945;

$\dfrac{1}{M} = 2.3025851$ (log 0.3622157);

C, the *compression* or meridional eccentricity of the earth

according to Clarke (1880) $= \dfrac{1}{293.465} = 0.003407562$ (log 7.5324437);

$e = \sqrt{2c - c^2} = 0.0824846$ (log 8.9163666);

from which

$\dfrac{a}{M} = 7915'.7044558$ (log 3.8984895);

$ae^2 = 23'.38871$ (log 1.3690072);

$\tfrac{1}{3}ae^4 = 0'.053042$ (log 8.7246192);

$\tfrac{1}{5}ae^6 = 0'.000216523$ (log 6.3355038).

The results are tabulated to one decimal place, which is sufficient for the ordinary problems of navigation.

The practical application of this table is illustrated in Chapters II and V, in articles treating of the Mercator Chart and Mercator Sailing.

### TABLE 4: LENGTH OF DEGREES OF LATITUDE AND LONGITUDE.

This table gives the length of a degree in both latitude and longitude at each parallel of latitude on the earth's surface, in nautical and statute miles and in meters, based upon Clarke's value (1866) of the earth's compression, $\dfrac{1}{299.15}$. In the case of latitude, the length relates to an arc of which the given degree is the center.

### TABLES 5A, 5B: DISTANCE BY TWO BEARINGS.

These tables have been calculated to facilitate the operation of finding the distance from an object by two bearings from a given distance run and course. In Table 5A the arguments are given in points, in Table 5B in degrees; the first column contains the multiplier of the distance run to give the distance of observed object at second bearing; the second, at time of passing abeam.

The method is explained in article 143, Chapter IV.

## TABLE 6: DISTANCE OF VISIBILITY OF OBJECTS.

This table contains the distances, in nautical and statute miles, at which any object is visible at sea. It is calculated by the formulæ:

$$d = 1.15 \sqrt{x}, \text{ and } d' = 1.32 \sqrt{x},$$

in which $d$ is the distance in nautical miles, $d'$ the distance in statute miles, and $x$ the height of the eye or the object in feet.

To find the distance of visibility of an object, the distance given by the table corresponding to its height should be added to that corresponding to the height of the observer's eye.

EXAMPLE: Required the distance of visibility of an object 420 feet high, the observer being at an elevation of 15 feet.

Dist. corresponding to 420 feet, 23.5 naut. miles.
Dist. corresponding to 15 feet, 4.4 naut. miles.

Dist. of visibility,      27.9 naut. miles.

## TABLE 7: CONVERSION OF ARC AND TIME.

In the first column of each pair in this table are contained angular measures expressed in arc (degrees, minutes, or seconds), and in the second column the corresponding angles expressed in time (hours, minutes, or seconds). As will be seen from the headings of columns, the time corresponding to degrees (°) is given in hours and minutes; to minutes of arc ('), in minutes and seconds of time; and to seconds of arc ("), in seconds and sixtieths of a second of time.

The table will be especially convenient in dealing with longitude and hour angle. The method of its employment is best illustrated by examples.

EXAMPLE I.

Required the time corresponding to 50° 31' 21".

| 50° | 00' | 00" | = 3$^h$ | 20$^m$ | 00$^s$ |
|---|---|---|---|---|---|
| | 31 | 00 | = | 2 | 04 |
| | | 21 | = | | 1$\frac{24}{60}$ |
| 50 | 31 | 21 | = 3 | 22 | 05.4 |

EXAMPLE II.

Required the arc corresponding to 6$^h$ 33$^m$ 26$^s$.5.

| 6$^h$ | 32$^m$ | 00$^s$ | = 98° | 00' | 00" |
|---|---|---|---|---|---|
| | 1 | 24 | = | 21 | 00 |
| | | 2$\frac{30}{60}$ | = | | 37.5 |
| 6 | 33 | 26.5 | = 98 | 21 | 37.5 |

## TABLES 8 AND 9: SIDEREAL AND MEAN SOLAR TIMES.

These tables give, respectively, the reductions necessary to convert intervals of sidereal time into those of mean solar time, and intervals of mean solar into those of sidereal time. The reduction for any interval is found by entering with the number of hours at the top and the number of minutes at the side, adding the reduction for seconds as given in the margin.

The relations between mean solar and sidereal time intervals, and the methods of conversion of these times, are given in articles 289–291, Chapter IX.

## TABLE 10: SUN'S RISING AND SETTING.

This table gives the local mean time of the sun's visible rising and setting—that is, of the appearance and disappearance of the sun's upper limb in the unobstructed horizon of a person whose eye is 15 feet above the level of the earth's surface, the atmospheric conditions being normal.

The local apparent times of rising and setting were determined from the formula for a time sight, the altitude employed being $-0°\ 56'\ 08''$, made up of the following terms: Refraction, $-36'\ 29''$; semi-diameter, $-16'\ 00''$; dip, $-3'\ 48''$; and parallax, $+9''$.

To ascertain the time of rising or setting for any given date and place, enter the table with the latitude and declination, interpolating if the degrees are not even. In the line R will be found the time of rising; in the line S, the time of setting. Be careful to choose the page in which the latitude is of the correct name, and in which the "approximate date" corresponds, nearly or exactly, with the given date.

This table is computed with the intention that, if accuracy is desired, it will be entered with the declination as an argument—not the date—as it is impossible to construct any table based upon dates whose application shall be general to all years. But as a given degree of declination will, in the majority of years, fall upon the date given in the table as the "approximate date," and as, when it does not do so, it can never be more than one day removed therefrom, it will answer, where a slight inaccuracy may be admitted, to enter the table with the date as an argument, thus avoiding the necessity of ascertaining the declination.

EXAMPLE: Find the local mean time of sunset at Rio de Janeiro, Brazil (lat. 22° 54' S., long. 43° 10' W.), on January 1, 1903 (dec. 23° 04' S.).

Exact method.

| Lat. 22° Dec. 23° } | ---------------- | 6$^h$ 48$^m$ |
|---|---|---|
| Corr. for + 54' lat | ........ | + 02 |
| Corr. for + 04' dec | ........ | 00 |
| L. M. T. sunset | .... | 6 50 |

Approximate method.

| Lat. 22°.. January 2 } | ---------------- | 6$^h$ 48$^m$ |
|---|---|---|
| Corr. for + 54' lat | .......... | + 02 |
| Corr. for 1 day | .............. | − 01 |
| L. M. T. sunset | ....... | 6 49 |

## TABLE 11: REDUCTION FOR MOON'S TRANSIT.

This table was calculated by proportioning the daily variation of the time of the moon's passing the meridian.

The numbers taken from the table are to be added to the Greenwich time of moon's transit in west longitude, but subtracted in east longitude.

## TABLE 12: REDUCTIONS FOR NAUTICAL ALMANAC.

This is a table of proportional parts for finding the variation of the sun's right ascension or declination, or of the equation of time, in any number of minutes of time, the horary motion being given at the top of the page in seconds, and the number of minutes of time in the side column; also for finding the variation of the moon's declination or right ascension in any number of seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

## TABLE 13: CHANGE OF SUN'S RIGHT ASCENSION.

This is a table that may be employed for finding the change of the sun's right ascension for any given number of hours, the hourly change, as taken from the Nautical Almanac, being given in the marginal columns.

## TABLE 14: DIP OF SEA HORIZON.

This table contains the dip of the sea horizon, calculated by the formula:

$$D = 58''.8 \sqrt{F},$$

in which F = height of the eye above the level of the sea in feet.

It is explained in article 300, Chapter X.

## TABLE 15: DIP SHORT OF HORIZON.

This table contains the dip for various distances and heights, calculated by the formula:

$$D = \frac{3}{7} d + 0.56514 \times \frac{h}{d},$$

in which D represents the dip in miles or minutes, $d$, the distance of the land in sea miles, and $h$, the height of the eye of the observer in feet.

## TABLE 16: PARALLAX OF SUN.

This table contains the sun's parallax in altitude calculated by the formula:

$$\text{par.} = \sin z \times 8''.75,$$

in which $z$ = apparent zenith distance, the sun's horizontal parallax being 8''.75.

It is explained in article 304, Chapter X.

## TABLE 17: PARALLAX OF PLANET.

Parallax in altitude of a planet is found by entering at the top with the planet's horizontal parallax, and at the side with the altitude.

## TABLE 18: AUGMENTATION OF MOON'S SEMIDIAMETER.

This table gives the augmentation of the moon's semidiameter calculated by the formula:

$$x = c\, s^2 \sin h + \tfrac{1}{2} c^2 s^3 \sin^2 h + \tfrac{1}{2} c^2 s^3,$$

where $h$ = moon's apparent altitude;
$s$ = moon's horizontal semidiameter;
$x$ = augmentation of semidiameter for altitude $h$; and
$\log c = 5.25021$.

## TABLE 19: AUGMENTATION OF MOON'S HORIZONTAL PARALLAX.

This table contains the augmentation of the moon's horizontal parallax, or the correction to reduce the moon's equatorial horizontal parallax to that point of the earth's axis which lies in the vertical of the observer in any given latitude; it is computed by the formulæ:

$$\triangle \pi = \pi\,(b-1), \qquad\qquad b = \frac{1}{\sqrt{(1 - e^2 \sin^2 L)}},$$

where $\pi$ = equatorial horizontal parallax;
$L$ = latitude;
$e$ = eccentricity of the meridian; $\log e^2 = 7.81602$; and
$\triangle \pi$ = augmentation of the horizontal parallax for the latitude L.

### TABLE 20A: MEAN REFRACTION.

This table gives the refraction, reduced from Bessel's tables, for a mean atmospheric condition in which the barometer is 30.00 inches, and thermometer 50° Fahr.

### TABLE 20B: MEAN REFRACTION AND PARALLAX OF SUN.

This table contains the correction to be applied to the sun's apparent altitude for mean refraction and parallax, being a combination of the quantities for the altitudes given in Tables 16 and 20A.

### TABLES 21, 22: CORRECTIONS OF REFRACTION FOR BAROMETER AND THERMOMETER.

These are deduced from Bessel's tables. The method of their employment will be evident.

### TABLE 23: MEAN REFRACTION AND MEAN PARALLAX OF MOON.

This table contains the correction of the moon's altitude for refraction and parallax corresponding to the mean refraction (Table 20A), and a horizontal parallax of the mean value of 57′ 30″.

### TABLE 24: MEAN REFRACTION AND PARALLAX OF MOON.

This table contains the correction to be applied to the moon's apparent altitude for each minute of horizontal parallax, and for every 10′ of altitude from 5°, with height of barometer 30.00 inches, and thermometer 50° Fahr.

For seconds of parallax, enter the table abreast the approximate correction and find the seconds of horizontal parallax, the tens of seconds at the side and the units at the top. Under the latter and opposite the former will be the seconds to add to the correction.

For minutes of altitude, take the seconds from the extreme right of the page, and apply them as there directed.

### TABLE 25: CHANGE OF ALTITUDE DUE TO CHANGE OF DECLINATION.

This table gives the variation of the altitude of any heavenly body arising from a change of 100″ in the declination. It is useful for finding the equation of equal altitudes by the approximate method explained in article 324, Chapter XI, and for other purposes.

If the change move the body toward the elevated pole, apply the correction to the altitude with the signs in the table; otherwise change the signs.

### TABLE 26: CHANGE OF ALTITUDE IN ONE MINUTE FROM MERIDIAN.

This table gives the variation of the altitude of any heavenly body, for one minute of time from meridian passage, for latitudes up to 60°, declinations to 63°, and altitudes between 6° and 86°. It is based upon the method set forth in article 334, Chapter XII, and the values may be computed by the formula:

$$a = \frac{1''.9635 \cos L \cos d}{\sin (L-d)}.$$

where $a$ = variation of altitude in one minute from meridian,

L = latitude, and

$d$ = declination—positive for same name and negative for opposite name to latitude at upper transit, and negative for same name at lower transit.

The limits of the table take in all values of latitude, declination, and altitude which are likely to be required. In its employment, care must be taken to enter the table at a place where the declination is appropriately named (of the same or opposite name to the latitude); it should also be noted that at the bottom of the last three pages values are given for the variation of a body at *lower* transit, which can only be observed when the declination and latitude are of the same name, and in which case the reduction to the meridian is subtractive; the limitations in this case are stated at the *foot* of the page, and apply to all values below the heavy rules.

### TABLE 27: CHANGE OF ALTITUDE IN GIVEN TIME FROM MERIDIAN.

This table gives the product of the variation in altitude in one minute of a heavenly body near the meridian, by the square of the number of minutes. Values are given for every half minute between $0^m 30^s$ and $26^m 0^s$, and for all variations likely to be employed in the method of "reduction to the meridian."

The formula for computing is:

Red. = $a \times t^2$,

where $a$ = variation in one minute (Table 26), and

$t$ = number of minutes (in units and tenths) from time of meridian passage.

The table is entered in the column of the nearest interval of time from meridian, and the value taken out corresponding to the value of $a$ found from Table 26. The units and tenths are picked out separately and combined, each being corrected by interpolation for intermediate intervals of time.

The result is the amount to be applied to the observed altitude to reduce it to the meridian altitude, which is always to be added for upper transits and subtracted for lower.

### TABLE 28, A, B, C, D: LATITUDE BY POLARIS.

The formula on which these tables are based is:

$$L = h - p \cos t + \tfrac{1}{2} p^2 \sin 1'' \sin^2 t \tan h$$
$$- \tfrac{1}{3} p^3 \sin^2 1'' \cos t \sin^2 t + \tfrac{1}{8} p^4 \sin^3 1'' \sin^4 t \tan^3 h;$$

in which

$L =$ the latitude of the place;
$h =$ the true altitude;
$p =$ the polar distance; and
$t =$ the hour angle of the star.

Table A contains for the declination 88° 48′, or $p_0 = 1° 12′ = 4320''$, the *first correction*,

$$A = - p_0 \cos t - \tfrac{1}{3} p^3_0 \sin^2 1'' \cos t \sin^2 t;$$

Argument, *the hour angle of the star*, or 24ʰ — the hour angle.
Table B contains the *second correction*,

$$B = \tfrac{1}{2} p^2_0 \sin 1'' \sin^2 t \tan h + \tfrac{1}{8} p^4_0 \sin^3 1'' \sin^4 t \tan^3 h;$$

Arguments, *the true altitude of the star* and the *hour angle*, or 24ʰ — *the hour angle.* This correction is always *additive.*
Table C contains the *third correction*, ·

$$C = \tfrac{1}{2} (p^2 - p^2_0) \sin 1'' \sin^2 t \tan h;$$

Arguments, *B* and *the declination of the star* from 88° 47′ 20″ to 88° 49′ 20″.
Table D contains the *fourth correction*,

$$- (p - p_0) \cos t - \tfrac{1}{3} (p^3 - p^3_0) \sin^2 1'' \cos t \sin^2 t;$$

Arguments, *A and the declination of the star* from 88° 47′ 20″ to 88° 49′ 20″.
The method of employing this table is illustrated in article 341, Chapter XII.

### TABLES 29, 30, 31: CONVERSION TABLES.

These are self-explanatory.

### TABLE 32: TRUE FORCE AND DIRECTION OF WIND.

This table enables an observer on board of a moving vessel to determine the true force and direction of the wind from its apparent force and direction. Enter the table with the apparent direction of the wind (number of points on the bow) and force (Beaufort scale) as arguments, and pick out the direction relatively to the ship's head and the force corresponding to the known speed of the ship.
EXAMPLE: A vessel steaming SE. at a speed of 15 knots appears to have a wind blowing from three points on the starboard bow with a force of 6, Beaufort scale. What is the true direction and force?
In the column headed 3 (meaning three points on bow, apparent direction) and in the line 6 (apparent force, Beaufort scale), we find abreast 15 (knots, speed of vessel) that the true direction is 5 points on starboard bow, *i. e.*, S. by W., and true force 4.

### TABLE 33: VERTICAL ANGLES.

This table gives the distance of an object of known height by the vertical angle that it subtends at the position of the observer. It was computed by the formula:

$$\tan \alpha = \frac{h}{d},$$

where $\alpha =$ the vertical angle;
$h =$ the height of the observed object in feet; and
$d =$ the distance of the object, also converted into feet.
The employment of this method of finding distance is explained in article 139, chapter IV.

### TABLE 34: HORIZON ANGLES.

This shows the distance in yards corresponding to any observed angle between an object and the sea horizon beyond, the observer being at a known height.
The method of use is explained in article 139, chapter IV.

### TABLE 35: SPEED TABLE.

This table shows the rate of speed, in nautical miles per hour, of a vessel which traverses a measured mile in any given number of minutes and seconds. It is entered with the number of minutes at the top and the number of seconds at the side; under one and abreast the other is the number of knots of speed.

## TABLE 36: LOCAL AND STANDARD TIMES.

This table contains the reduction to be applied to the local time to obtain the corresponding time at any other meridian whose time is adopted as a standard. The results are given to the nearest minute of time only, being intended for the reduction of such approximate quantities as the time of high water or time of sunset. More exact reductions, when required, may be made by Table 7.

## TABLE 37: LOGARITHMS FOR EQUAL ALTITUDE SIGHTS.

Logarithms of A and B, for computing the Equation of Equal Altitudes, are calculated by the formulae:

$$A = \frac{E}{1800 \sin \frac{1}{2} E}, \qquad B = \frac{E}{1800 \tan \frac{1}{2} E},$$

where E in the numerator is the elapsed time in minutes, and E in the denominator the elapsed time expressed in arc.

If we put

$L$ = latitude of the place of observation, + north, — south,
$d$ = declination of the sun, + north, — south,
$n$ = hourly change of declination, + north, — south,
$C$ = correction to reduce the middle chronometer time to chronometer time of apparent noon, algebraically additive,
$C'$ = the same for midnight,

we have

$$C = - A\, n \tan L + B\, n \tan d;$$
$$C' = \phantom{-} A\, n \tan L + B\, n \tan d.$$

This is Chauvenet's table to aid the solution of the problem of Equal Altitudes, and is explained in article 322 and following articles, Chapter XI.

## TABLE 38: EFFECT UPON LONGITUDE OF ERROR IN LATITUDE.

Table 38 shows, approximately, the error in longitude in miles and tenths of a mile, occasioned by an error of one mile in the latitude.

Thus, when the sun's altitude is 30°, the latitude 30°, and the polar distance 100°, the error is eight-tenths of a mile.

The effect of an *increase* of latitude is as follows:

In *West* longitude, { East } of meridian, the { decreased } except where marked { increased } the body being { West } longitude is . { increased }' by *, when it is. { decreased }.

In *East* longitude, { East } of meridian, the { increased } except where marked { decreased } the body being { West } longitude is { decreased }' by *, when it is { increased }.

A *decrease* of latitude has the contrary effect.

The direction of error may readily be seen by drawing the Sumner line in a direction at right angles to the approximate bearing of the body.

## TABLE 39: AMPLITUDES.

This table contains amplitudes of heavenly bodies, at rising and setting, for various latitudes and declinations, computed by the formula:

$$\sin \text{amp.} = \sec \text{Lat.} \times \sin \text{dec.}$$

It is entered with the declination at the top and the latitude at the side.
Its use is explained in article 358, Chapter XIV.

## TABLE 40: CORRECTION FOR AMPLITUDES.

This table gives a correction to be applied to the observed amplitude to counteract the vertical displacement due to refraction, parallax, and dip, when the body is observed with its center in the visible horizon.

The correction is to be applied for the sun, a planet, or a star, as follows:

At Rising in N. Lat.
Setting in S. Lat. } apply the correction to the right.

At Rising in S. Lat.
Setting in N. Lat. } apply the correction to the left.

For the moon, apply *half* the correction in the *contrary* manner.

## TABLE 41: NATURAL SINES AND COSINES.

This table contains the natural sine and cosine for every minute of the quadrant, and is to be entered at the top or bottom with the degrees, and at the side marked M., with the minutes; the corresponding numbers will be the natural sine and cosine, respectively, observing that if the degrees are found at the top, the name sine, cosine, and M. must also be found at the top, and the contrary if the degrees are found at the bottom. It should be understood that all numbers given in the table should be divided by 100,000—that is, pointed off to contain five decimal places. Thus, .43366 is the natural sine of 25° 42′, or the cosine of 64° 18′.

In the outer columns of the margin are given tables of proportional parts, for the purpose of finding, approximately, by inspection, the proportional part corresponding to any number of seconds in the proposed angle, the seconds being found in the marginal column marked M., and the correction in the adjoining column. Thus, if we suppose that it were required to find the natural sine corresponding to 25° 42′ 19″, the difference of the sines of 25° 42′ and 25° 43′ is 26, being the same as at the top of the left-hand column of the table; and in this column, and opposite 19 in the column M., is the correction 8. *Adding* this to the above number .43366, because the numbers are *increasing*, we get .43374 for the sine of 25° 42′ 19″. In like manner, we find the cosine of the same angle to be .90108 − 4 = .90104, using the right-hand columns, and *subtracting* because the numbers are *decreasing;* observing, however, that the number 14 at the top of this column varies 1 from the difference between the cosines of 25° 42′ and 25° 43′, which is only 13; so that the table may give in some cases a unit too much between the angles 25° 42′ and 25° 43′; but this is, in general, of but little importance, and when accuracy is required, the usual method of proportional parts is to be resorted to, using the actual tabular difference.

## TABLE 42: LOGARITHMS OF NUMBERS.

This table, containing the common logarithms of numbers, was compared with Sherwin's, Hutton's, and Taylor's logarithms; its use is explained in an article on Logarithms in Appendix III.

## TABLE 43: LOGARITHMS OF TRIGONOMETRIC FUNCTIONS, QUARTER POINTS.

This table contains the logarithms of the sines, tangents, etc., corresponding to points and quarter points of the compass. This was compared with Sherwin's, Hutton's, and Taylor's logarithms.

## TABLE 44: LOGARITHMS OF TRIGONOMETRIC FUNCTIONS, DEGREES.

This table contains the common logarithms of the sines, tangents, secants, etc. It was compared with Sherwin's, Hutton's, and Taylor's tables. Two additional columns are given in this table, which are very convenient in finding the time from an altitude of the sun; also, three columns of proportional parts for seconds of space, and a small table at the bottom of each page for finding the proportional parts for seconds of time. The degrees are marked to 180°, which saves the trouble of subtracting the given angle from 180° when it exceeds 90°.

The use of this table is fully explained in Appendix III in an article on Logarithms.

# TABLE 1.

### Difference of Latitude and Departure for ¼ Point.

| | N. ¼ E. | | | N. ¼ W. | | | S. ¼ E. | | | S. ¼ W. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 1.0 | 0.0 | 61 | 60.9 | 3.0 | 121 | 120.9 | 5.9 | 181 | 180.8 | 8.9 | 241 | 240.7 | 11.8 |
| 2 | 2.0 | 0.1 | 62 | 61.9 | 3.0 | 22 | 121.9 | 6.0 | 82 | 181.8 | 8.9 | 42 | 241.7 | 11.9 |
| 3 | 3.0 | 0.1 | 63 | 62.9 | 3.1 | 23 | 122.9 | 6.0 | 83 | 182.8 | 9.0 | 43 | 242.7 | 11.9 |
| 4 | 4.0 | 0.2 | 64 | 63.9 | 3.1 | 24 | 123.9 | 6.1 | 84 | 183.8 | 9.0 | 44 | 243.7 | 12.0 |
| 5 | 5.0 | 0.2 | 65 | 64.9 | 3.2 | 25 | 124.8 | 6.1 | 85 | 184.8 | 9.1 | 45 | 244.7 | 12.0 |
| 6 | 6.0 | 0.3 | 66 | 65.9 | 3.2 | 26 | 125.8 | 6.2 | 86 | 185.8 | 9.1 | 46 | 245.7 | 12.1 |
| 7 | 7.0 | 0.3 | 67 | 66.9 | 3.3 | 27 | 126.8 | 6.2 | 87 | 186.8 | 9.2 | 47 | 246.7 | 12.1 |
| 8 | 8.0 | 0.4 | 68 | 67.9 | 3.3 | 28 | 127.8 | 6.3 | 88 | 187.8 | 9.2 | 48 | 247.7 | 12.2 |
| 9 | 9.0 | 0.4 | 69 | 68.9 | 3.4 | 29 | 128.8 | 6.3 | 89 | 188.8 | 9.3 | 49 | 248.7 | 12.2 |
| 10 | 10.0 | 0.5 | 70 | 69.9 | 3.4 | 30 | 129.8 | 6.4 | 90 | 189.8 | 9.3 | 50 | 249.7 | 12.3 |
| 11 | 11.0 | 0.5 | 71 | 70.9 | 3.5 | 131 | 130.8 | 6.4 | 191 | 190.8 | 9.4 | 251 | 250.7 | 12.3 |
| 12 | 12.0 | 0.6 | 72 | 71.9 | 3.5 | 32 | 131.8 | 6.5 | 92 | 191.8 | 9.4 | 52 | 251.7 | 12.4 |
| 13 | 13.0 | 0.6 | 73 | 72.9 | 3.6 | 33 | 132.8 | 6.5 | 93 | 192.8 | 9.5 | 53 | 252.7 | 12.4 |
| 14 | 14.0 | 0.7 | 74 | 73.9 | 3.6 | 34 | 133.8 | 6.6 | 94 | 193.8 | 9.5 | 54 | 253.7 | 12.5 |
| 15 | 15.0 | 0.7 | 75 | 74.9 | 3.7 | 35 | 134.8 | 6.6 | 95 | 194.8 | 9.6 | 55 | 254.7 | 12.5 |
| 16 | 16.0 | 0.8 | 76 | 75.9 | 3.7 | 36 | 135.8 | 6.7 | 96 | 195.8 | 9.6 | 56 | 255.7 | 12.6 |
| 17 | 17.0 | 0.8 | 77 | 76.9 | 3.8 | 37 | 136.8 | 6.7 | 97 | 196.8 | 9.7 | 57 | 256.7 | 12.6 |
| 18 | 18.0 | 0.9 | 78 | 77.9 | 3.8 | 38 | 137.8 | 6.8 | 98 | 197.8 | 9.7 | 58 | 257.7 | 12.7 |
| 19 | 19.0 | 0.9 | 79 | 78.9 | 3.9 | 39 | 138.8 | 6.8 | 99 | 198.8 | 9.8 | 59 | 258.7 | 12.7 |
| 20 | 20.0 | 1.0 | 80 | 79.9 | 3.9 | 40 | 139.8 | 6.9 | 200 | 199.8 | 9.8 | 60 | 259.7 | 12.8 |
| 21 | 21.0 | 1.0 | 81 | 80.9 | 4.0 | 141 | 140.8 | 6.9 | 201 | 200.8 | 9.9 | 261 | 260.7 | 12.8 |
| 22 | 22.0 | 1.1 | 82 | 81.9 | 4.0 | 42 | 141.8 | 7.0 | 02 | 201.8 | 9.9 | 62 | 261.7 | 12.9 |
| 23 | 23.0 | 1.1 | 83 | 82.9 | 4.1 | 43 | 142.8 | 7.0 | 03 | 202.8 | 10.0 | 63 | 262.7 | 12.9 |
| 24 | 24.0 | 1.2 | 84 | 83.9 | 4.1 | 44 | 143.8 | 7.1 | 04 | 203.8 | 10.0 | 64 | 263.7 | 13.0 |
| 25 | 25.0 | 1.2 | 85 | 84.9 | 4.2 | 45 | 144.8 | 7.1 | 05 | 204.8 | 10.1 | 65 | 264.7 | 13.0 |
| 26 | 26.0 | 1.3 | 86 | 85.9 | 4.2 | 46 | 145.8 | 7.2 | 06 | 205.8 | 10.1 | 66 | 265.7 | 13.1 |
| 27 | 27.0 | 1.3 | 87 | 86.9 | 4.3 | 47 | 146.8 | 7.2 | 07 | 206.8 | 10.2 | 67 | 266.7 | 13.1 |
| 28 | 28.0 | 1.4 | 88 | 87.9 | 4.3 | 48 | 147.8 | 7.3 | 08 | 207.7 | 10.2 | 68 | 267.7 | 13.2 |
| 29 | 29.0 | 1.4 | 89 | 88.9 | 4.4 | 49 | 148.8 | 7.3 | 09 | 208.7 | 10.3 | 69 | 268.7 | 13.2 |
| 30 | 30.0 | 1.5 | 90 | 89.9 | 4.4 | 50 | 149.8 | 7.4 | 10 | 209.7 | 10.3 | 70 | 269.7 | 13.2 |
| 31 | 31.0 | 1.5 | 91 | 90.9 | 4.5 | 151 | 150.8 | 7.4 | 211 | 210.7 | 10.4 | 271 | 270.7 | 13.3 |
| 32 | 32.0 | 1.6 | 92 | 91.9 | 4.5 | 52 | 151.8 | 7.5 | 12 | 211.7 | 10.4 | 72 | 271.7 | 13.3 |
| 33 | 33.0 | 1.6 | 93 | 92.9 | 4.6 | 53 | 152.8 | 7.5 | 13 | 212.7 | 10.5 | 73 | 272.7 | 13.4 |
| 34 | 34.0 | 1.7 | 94 | 93.9 | 4.6 | 54 | 153.8 | 7.6 | 14 | 213.7 | 10.5 | 74 | 273.7 | 13.4 |
| 35 | 35.0 | 1.7 | 95 | 94.9 | 4.7 | 55 | 154.8 | 7.6 | 15 | 214.7 | 10.5 | 75 | 274.7 | 13.5 |
| 36 | 36.0 | 1.8 | 96 | 95.9 | 4.7 | 56 | 155.8 | 7.7 | 16 | 215.7 | 10.6 | 76 | 275.7 | 13.5 |
| 37 | 37.0 | 1.8 | 97 | 96.9 | 4.8 | 57 | 156.8 | 7.7 | 17 | 216.7 | 10.6 | 77 | 276.7 | 13.6 |
| 38 | 38.0 | 1.9 | 98 | 97.9 | 4.8 | 58 | 157.8 | 7.8 | 18 | 217.7 | 10.7 | 78 | 277.7 | 13.6 |
| 39 | 39.0 | 1.9 | 99 | 98.9 | 4.9 | 59 | 158.8 | 7.8 | 19 | 218.7 | 10.7 | 79 | 278.7 | 13.7 |
| 40 | 40.0 | 2.0 | 100 | 99.9 | 4.9 | 60 | 159.8 | 7.9 | 20 | 219.7 | 10.8 | 80 | 279.7 | 13.7 |
| 41 | 41.0 | 2.0 | 101 | 100.9 | 5.0 | 161 | 160.8 | 7.9 | 221 | 220.7 | 10.8 | 281 | 280.7 | 13.8 |
| 42 | 41.9 | 2.1 | 02 | 101.9 | 5.0 | 62 | 161.8 | 7.9 | 22 | 221.7 | 10.9 | 82 | 281.7 | 13.8 |
| 43 | 42.9 | 2.1 | 03 | 102.9 | 5.1 | 63 | 162.8 | 8.0 | 23 | 222.7 | 10.9 | 83 | 282.7 | 13.9 |
| 44 | 43.9 | 2.2 | 04 | 103.9 | 5.1 | 64 | 163.8 | 8.0 | 24 | 223.7 | 11.0 | 84 | 283.7 | 13.9 |
| 45 | 44.9 | 2.2 | 05 | 104.9 | 5.2 | 65 | 164.8 | 8.1 | 25 | 224.7 | 11.0 | 85 | 284.7 | 14.0 |
| 46 | 45.9 | 2.3 | 06 | 105.9 | 5.2 | 66 | 165.8 | 8.1 | 26 | 225.7 | 11.1 | 86 | 285.7 | 14.0 |
| 47 | 46.9 | 2.3 | 07 | 106.9 | 5.3 | 67 | 166.8 | 8.2 | 27 | 226.7 | 11.1 | 87 | 286.7 | 14.1 |
| 48 | 47.9 | 2.4 | 08 | 107.9 | 5.3 | 68 | 167.8 | 8.2 | 28 | 227.7 | 11.2 | 88 | 287.7 | 14.1 |
| 49 | 48.9 | 2.4 | 09 | 108.9 | 5.3 | 69 | 168.8 | 8.3 | 29 | 228.7 | 11.2 | 89 | 288.7 | 14.2 |
| 50 | 49.9 | 2.5 | 10 | 109.9 | 5.4 | 70 | 169.8 | 8.3 | 30 | 229.7 | 11.3 | 90 | 289.7 | 14.2 |
| 51 | 50.9 | 2.5 | 111 | 110.9 | 5.4 | 171 | 170.8 | 8.4 | 231 | 230.7 | 11.3 | 291 | 290.6 | 14.3 |
| 52 | 51.9 | 2.6 | 12 | 111.9 | 5.5 | 72 | 171.8 | 8.4 | 32 | 231.7 | 11.4 | 92 | 291.6 | 14.3 |
| 53 | 52.9 | 2.6 | 13 | 112.9 | 5.5 | 73 | 172.8 | 8.5 | 33 | 232.7 | 11.4 | 93 | 292.6 | 14.4 |
| 54 | 53.9 | 2.6 | 14 | 113.9 | 5.6 | 74 | 173.8 | 8.5 | 34 | 233.7 | 11.5 | 94 | 293.6 | 14.4 |
| 55 | 54.9 | 2.7 | 15 | 114.9 | 5.6 | 75 | 174.8 | 8.6 | 35 | 234.7 | 11.5 | 95 | 294.6 | 14.5 |
| 56 | 55.9 | 2.7 | 16 | 115.9 | 5.7 | 76 | 175.8 | 8.6 | 36 | 235.7 | 11.6 | 96 | 295.6 | 14.5 |
| 57 | 56.9 | 2.8 | 17 | 116.9 | 5.7 | 77 | 176.8 | 8.7 | 37 | 236.7 | 11.6 | 97 | 296.6 | 14.6 |
| 58 | 57.9 | 2.8 | 18 | 117.9 | 5.8 | 78 | 177.8 | 8.7 | 38 | 237.7 | 11.7 | 98 | 297.6 | 14.6 |
| 59 | 58.9 | 2.9 | 19 | 118.9 | 5.8 | 79 | 178.8 | 8.8 | 39 | 238.7 | 11.7 | 99 | 298.6 | 14.7 |
| 60 | 59.9 | 2.9 | 20 | 119.9 | 5.9 | 80 | 179.8 | 8.8 | 40 | 239.7 | 11.8 | 300 | 299.6 | 14.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| E. ¼ N. | E. ¼ S. | W. ¼ N. | W. ¼ S. | [For 7¾ Points. |

TABLE 1. [Page 353

Difference of Latitude and Departure for ½ Point.

| N. ½ E. | | | N. ½ W. | | | S. ½ E. | | | S. ½ W. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 1.0 | 0.1 | 61 | 60.7 | 6.0 | 121 | 120.4 | 11.9 | 181 | 180.1 | 17.7 | 241 | 239.8 | 23.6 |
| 2 | 2.0 | 0.2 | 62 | 61.7 | 6.1 | 22 | 121.4 | 12.0 | 82 | 181.1 | 17.8 | 42 | 240.8 | 23.7 |
| 3 | 3.0 | 0.3 | 63 | 62.7 | 6.2 | 23 | 122.4 | 12.1 | 83 | 182.1 | 17.9 | 43 | 241.8 | 23.8 |
| 4 | 4.0 | 0.4 | 64 | 63.7 | 6.3 | 24 | 123.4 | 12.2 | 84 | 183.1 | 18.0 | 44 | 242.8 | 23.9 |
| 5 | 5.0 | 0.5 | 65 | 64.7 | 6.4 | 25 | 124.4 | 12.3 | 85 | 184.1 | 18.1 | 45 | 243.8 | 24.0 |
| 6 | 6.0 | 0.6 | 66 | 65.7 | 6.5 | 26 | 125.4 | 12.4 | 86 | 185.1 | 18.2 | 46 | 244.8 | 24.1 |
| 7 | 7.0 | 0.7 | 67 | 66.7 | 6.6 | 27 | 126.4 | 12.4 | 87 | 186.1 | 18.3 | 47 | 245.8 | 24.2 |
| 8 | 8.0 | 0.8 | 68 | 67.7 | 6.7 | 28 | 127.4 | 12.5 | 88 | 187.1 | 18.4 | 48 | 246.8 | 24.3 |
| 9 | 9.0 | 0.9 | 69 | 68.7 | 6.8 | 29 | 128.4 | 12.6 | 89 | 188.1 | 18.5 | 49 | 247.8 | 24.4 |
| 10 | 10.0 | 1.0 | 70 | 69.7 | 6.9 | 30 | 129.4 | 12.7 | 90 | 189.1 | 18.6 | 50 | 248.8 | 24.5 |
| 11 | 10.9 | 1.1 | 71 | 70.7 | 7.0 | 131 | 130.4 | 12.8 | 191 | 190.1 | 18.7 | 251 | 249.8 | 24.6 |
| 12 | 11.9 | 1.2 | 72 | 71.7 | 7.1 | 32 | 131.4 | 12.9 | 92 | 191.1 | 18.8 | 52 | 250.8 | 24.7 |
| 13 | 12.9 | 1.3 | 73 | 72.6 | 7.2 | 33 | 132.4 | 13.0 | 93 | 192.1 | 18.9 | 53 | 251.8 | 24.8 |
| 14 | 13.9 | 1.4 | 74 | 73.6 | 7.3 | 34 | 133.4 | 13.1 | 94 | 193.1 | 19.0 | 54 | 252.8 | 24.9 |
| 15 | 14.9 | 1.5 | 75 | 74.6 | 7.4 | 35 | 134.3 | 13.2 | 95 | 194.1 | 19.1 | 55 | 253.8 | 25.0 |
| 16 | 15.9 | 1.6 | 76 | 75.6 | 7.4 | 36 | 135.3 | 13.3 | 96 | 195.1 | 19.2 | 56 | 254.8 | 25.1 |
| 17 | 16.9 | 1.7 | 77 | 76.6 | 7.5 | 37 | 136.3 | 13.4 | 97 | 196.1 | 19.3 | 57 | 255.8 | 25.2 |
| 18 | 17.9 | 1.8 | 78 | 77.6 | 7.6 | 38 | 137.3 | 13.5 | 98 | 197.0 | 19.4 | 58 | 256.8 | 25.3 |
| 19 | 18.9 | 1.9 | 79 | 78.6 | 7.7 | 39 | 138.3 | 13.6 | 99 | 198.0 | 19.5 | 59 | 257.8 | 25.4 |
| 20 | 19.9 | 2.0 | 80 | 79.6 | 7.8 | 40 | 139.3 | 13.7 | 200 | 199.0 | 19.6 | 60 | 258.7 | 25.5 |
| 21 | 20.9 | 2.1 | 81 | 80.6 | 7.9 | 141 | 140.3 | 13.8 | 201 | 200.0 | 19.7 | 261 | 259.7 | 25.6 |
| 22 | 21.9 | 2.2 | 82 | 81.6 | 8.0 | 42 | 141.3 | 13.9 | 02 | 201.0 | 19.8 | 62 | 260.7 | 25.7 |
| 23 | 22.9 | 2.3 | 83 | 82.6 | 8.1 | 43 | 142.3 | 14.0 | 03 | 202.0 | 19.9 | 63 | 261.7 | 25.8 |
| 24 | 23.9 | 2.4 | 84 | 83.6 | 8.2 | 44 | 143.3 | 14.1 | 04 | 203.0 | 20.0 | 64 | 262.7 | 25.9 |
| 25 | 24.9 | 2.5 | 85 | 84.6 | 8.3 | 45 | 144.3 | 14.2 | 05 | 204.0 | 20.1 | 65 | 263.7 | 26.0 |
| 26 | 25.9 | 2.5 | 86 | 85.6 | 8.4 | 46 | 145.3 | 14.3 | 06 | 205.0 | 20.2 | 66 | 264.7 | 26.1 |
| 27 | 26.9 | 2.6 | 87 | 86.6 | 8.5 | 47 | 146.3 | 14.4 | 07 | 206.0 | 20.3 | 67 | 265.7 | 26.2 |
| 28 | 27.9 | 2.7 | 88 | 87.6 | 8.6 | 48 | 147.3 | 14.5 | 08 | 207.0 | 20.4 | 68 | 266.7 | 26.3 |
| 29 | 28.9 | 2.8 | 89 | 88.6 | 8.7 | 49 | 148.3 | 14.6 | 09 | 208.0 | 20.5 | 69 | 267.7 | 26.4 |
| 30 | 29.9 | 2.9 | 90 | 89.6 | 8.8 | 50 | 149.3 | 14.7 | 10 | 209.0 | 20.6 | 70 | 268.7 | 26.5 |
| 31 | 30.9 | 3.0 | 91 | 90.6 | 8.9 | 151 | 150.3 | 14.8 | 211 | 210.0 | 20.7 | 271 | 269.7 | 26.6 |
| 32 | 31.8 | 3.1 | 92 | 91.6 | 9.0 | 52 | 151.3 | 14.9 | 12 | 211.0 | 20.8 | 72 | 270.7 | 26.7 |
| 33 | 32.8 | 3.2 | 93 | 92.6 | 9.1 | 53 | 152.3 | 15.0 | 13 | 212.0 | 20.9 | 73 | 271.7 | 26.8 |
| 34 | 33.8 | 3.3 | 94 | 93.5 | 9.2 | 54 | 153.3 | 15.1 | 14 | 213.0 | 21.0 | 74 | 272.7 | 26.9 |
| 35 | 34.8 | 3.4 | 95 | 94.5 | 9.3 | 55 | 154.3 | 15.2 | 15 | 214.0 | 21.1 | 75 | 273.7 | 27.0 |
| 36 | 35.8 | 3.5 | 96 | 95.5 | 9.4 | 56 | 155.2 | 15.3 | 16 | 215.0 | 21.2 | 76 | 274.7 | 27.1 |
| 37 | 36.8 | 3.6 | 97 | 96.5 | 9.5 | 57 | 156.2 | 15.4 | 17 | 216.0 | 21.3 | 77 | 275.7 | 27.2 |
| 38 | 37.8 | 3.7 | 98 | 97.5 | 9.6 | 58 | 157.2 | 15.5 | 18 | 217.0 | 21.4 | 78 | 276.7 | 27.2 |
| 39 | 38.8 | 3.8 | 99 | 98.5 | 9.7 | 59 | 158.2 | 15.6 | 19 | 217.9 | 21.5 | 79 | 277.7 | 27.3 |
| 40 | 39.8 | 3.9 | 100 | 99.5 | 9.8 | 60 | 159.2 | 15.7 | 20 | 218.9 | 21.6 | 80 | 278.7 | 27.4 |
| 41 | 40.8 | 4.0 | 101 | 100.5 | 9.9 | 161 | 160.2 | 15.8 | 221 | 219.9 | 21.7 | 281 | 279.6 | 27.5 |
| 42 | 41.8 | 4.1 | 02 | 101.5 | 10.0 | 62 | 161.2 | 15.9 | 22 | 220.9 | 21.8 | 82 | 280.6 | 27.6 |
| 43 | 42.8 | 4.2 | 03 | 102.5 | 10.1 | 63 | 162.2 | 16.0 | 23 | 221.9 | 21.9 | 83 | 281.6 | 27.7 |
| 44 | 43.8 | 4.3 | 04 | 103.5 | 10.2 | 64 | 163.2 | 16.1 | 24 | 222.9 | 22.0 | 84 | 282.6 | 27.8 |
| 45 | 44.8 | 4.4 | 05 | 104.5 | 10.3 | 65 | 164.2 | 16.2 | 25 | 223.9 | 22.1 | 85 | 283.6 | 27.9 |
| 46 | 45.8 | 4.5 | 06 | 105.5 | 10.4 | 66 | 165.2 | 16.3 | 26 | 224.9 | 22.2 | 86 | 284.6 | 28.0 |
| 47 | 46.8 | 4.6 | 07 | 106.5 | 10.5 | 67 | 166.2 | 16.4 | 27 | 225.9 | 22.2 | 87 | 285.6 | 28.1 |
| 48 | 47.8 | 4.7 | 08 | 107.5 | 10.6 | 68 | 167.2 | 16.5 | 28 | 226.9 | 22.3 | 88 | 286.6 | 28.2 |
| 49 | 48.8 | 4.8 | 09 | 108.5 | 10.7 | 69 | 168.2 | 16.6 | 29 | 227.9 | 22.4 | 89 | 287.6 | 28.3 |
| 50 | 49.8 | 4.9 | 10 | 109.5 | 10.8 | 70 | 169.2 | 16.7 | 30 | 228.9 | 22.5 | 90 | 288.6 | 28.4 |
| 51 | 50.8 | 5.0 | 111 | 110.5 | 10.9 | 171 | 170.2 | 16.8 | 231 | 229.9 | 22.6 | 291 | 289.6 | 28.5 |
| 52 | 51.7 | 5.1 | 12 | 111.5 | 11.0 | 72 | 171.2 | 16.9 | 32 | 230.9 | 22.7 | 92 | 290.6 | 28.6 |
| 53 | 52.7 | 5.2 | 13 | 112.5 | 11.1 | 73 | 172.2 | 17.0 | 33 | 231.9 | 22.8 | 93 | 291.6 | 28.7 |
| 54 | 53.7 | 5.3 | 14 | 113.5 | 11.2 | 74 | 173.2 | 17.1 | 34 | 232.9 | 22.9 | 94 | 292.6 | 28.8 |
| 55 | 54.7 | 5.4 | 15 | 114.4 | 11.3 | 75 | 174.2 | 17.2 | 35 | 233.9 | 23.0 | 95 | 293.6 | 28.9 |
| 56 | 55.7 | 5.5 | 16 | 115.4 | 11.4 | 76 | 175.2 | 17.3 | 36 | 234.9 | 23.1 | 96 | 294.6 | 29.0 |
| 57 | 56.7 | 5.6 | 17 | 116.4 | 11.5 | 77 | 176.1 | 17.3 | 37 | 235.9 | 23.2 | 97 | 295.6 | 29.1 |
| 58 | 57.7 | 5.7 | 18 | 117.4 | 11.6 | 78 | 177.1 | 17.4 | 38 | 236.9 | 23.3 | 98 | 296.6 | 29.2 |
| 59 | 58.7 | 5.8 | 19 | 118.4 | 11.7 | 79 | 178.1 | 17.5 | 39 | 237.8 | 23.4 | 99 | 297.6 | 29.3 |
| 60 | 59.7 | 5.9 | 20 | 119.4 | 11.8 | 80 | 179.1 | 17.6 | 40 | 238.8 | 23.5 | 300 | 298.6 | 29.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |
| E. ½ N. | | | E. ½ S. | | | W. ½ N. | | | W ½ S. | | | [For 7½ Points. | | |

# TABLE 1.

Difference of Latitude and Departure for ¾ Point.

| | N. ¾ E. | | | N. ¾ W. | | | S. ¾ E. | | | S. ¾ W. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 1.0 | 0.1 | 61 | 60.3 | 9.0 | 121 | 119.7 | 17.8 | 181 | 179.0 | 26.6 | 241 | 238.4 | 35.4 |
| 2 | 2.0 | 0.3 | 62 | 61.3 | 9.1 | 22 | 120.7 | 17.9 | 82 | 180.0 | 26.7 | 42 | 239.4 | 35.5 |
| 3 | 3.0 | 0.4 | 63 | 62.3 | 9.2 | 23 | 121.7 | 18.0 | 83 | 181.0 | 26.9 | 43 | 240.4 | 35.7 |
| 4 | 4.0 | 0.6 | 64 | 63.3 | 9.4 | 24 | 122.7 | 18.2 | 84 | 182.0 | 27.0 | 44 | 241.4 | 35.8 |
| 5 | 4.9 | 0.7 | 65 | 64.3 | 9.5 | 25 | 123.6 | 18.3 | 85 | 183.0 | 27.1 | 45 | 242.3 | 35.9 |
| 6 | 5.9 | 0.9 | 66 | 65.3 | 9.7 | 26 | 124.6 | 18.5 | 86 | •184.0 | 27.3 | 46 | 243.3 | 36.1 |
| 7 | 6.9 | 1.0 | 67 | 66.3 | 9.8 | 27 | 125.6 | 18.6 | 87 | 185.0 | 27.4 | 47 | 244.3 | 36.2 |
| 8 | 7.9 | 1.2 | 68 | 67.3 | 10.0 | 28 | 126.6 | 18.8 | 88 | 186.0 | 27.6 | 48 | 245.3 | 36.4 |
| 9 | 8.9 | 1.3 | 69 | 68.3 | 10.1 | 29 | 127.6 | 18.9 | 89 | 187.0 | 27.7 | 49 | 246.3 | 36.5 |
| 10 | 9.9 | 1.5 | 70 | 69.2 | 10.3 | 30 | 128.6 | 19.1 | 90 | 187.9 | 27.9 | 50 | 247.3 | 36.7 |
| 11 | 10.9 | 1.6 | 71 | 70.2 | 10.4 | 131 | 129.6 | 19.2 | 191 | 188.9 | 28.0 | 251 | 248.3 | 36.8 |
| 12 | 11.9 | 1.8 | 72 | 71.2 | 10.6 | 32 | 130.6 | 19.4 | 92 | 189.9 | 28.2 | 52 | 249.3 | 37.0 |
| 13 | 12.9 | 1.9 | 73 | 72.2 | 10.7 | 33 | 131.6 | 19.5 | 93 | 190.9 | 28.3 | 53 | 250.3 | 37.1 |
| 14 | 13.8 | 2.1 | 74 | 73.2 | 10.9 | 34 | 132.5 | 19.7 | 94 | 191.9 | 28.5 | 54 | 251.3 | 37.3 |
| 15 | 14.8 | 2.2 | 75 | 74.2 | 11.0 | 35 | 133.5 | 19.8 | 95 | 192.9 | 28.6 | 55 | 252.2 | 37.4 |
| 16 | 15.8 | 2.3 | 76 | 75.2 | 11.2 | 36 | 134.5 | 20.0 | 96 | 193.9 | 28.8 | 56 | 253.2 | 37.6 |
| 17 | 16.8 | 2.5 | 77 | 76.2 | 11.3 | 37 | 135.5 | 20.1 | 97 | 194.9 | 28.9 | 57 | 254.2 | 37.7 |
| 18 | 17.8 | 2.6 | 78 | 77.2 | 11.4 | 38 | 136.5 | 20.2 | 98 | 195.9 | 29.1 | 58 | 255.2 | 37.9 |
| 19 | 18.8 | 2.8 | 79 | 78.1 | 11.6 | 39 | 137.5 | 20.4 | 99 | 196.8 | 29.2 | 59 | 256.2 | 38.0 |
| 20 | 19.8 | 2.9 | 80 | 79.1 | 11.7 | 40 | 138.5 | 20.5 | 200 | 197.8 | 29.3 | 60 | 257.2 | 38.1 |
| 21 | 20.8 | 3.1 | 81 | 80.1 | 11.9 | 141 | 139.5 | 20.7 | 201 | 198.8 | 29.5 | 261 | 258.2 | 38.3 |
| 22 | 21.8 | 3.2 | 82 | 81.1 | 12.0 | 42 | 140.5 | 20.8 | 02 | 199.8 | 29.6 | 62 | 259.2 | 38.4 |
| 23 | 22.8 | 3.4 | 83 | 82.1 | 12.2 | 43 | 141.5 | 21.0 | 03 | 200.8 | 29.8 | 63 | 260.2 | 38.6 |
| 24 | 23.7 | 3.5 | 84 | 83.1 | 12.3 | 44 | 142.4 | 21.1 | 04 | 201.8 | 29.9 | 64 | 261.1 | 38.7 |
| 25 | 24.7 | 3.7 | 85 | 84.1 | 12.5 | 45 | 143.4 | 21.3 | 05 | 202.8 | 30.1 | 65 | 262.1 | 38.9 |
| 26 | 25.7 | 3.8 | 86 | 85.1 | 12.6 | 46 | 144.4 | 21.4 | 06 | 203.8 | 30.2 | 66 | 263.1 | 39.0 |
| 27 | 26.7 | 4.0 | 87 | 86.1 | 12.8 | 47 | 145.4 | 21.6 | 07 | 204.8 | 30.4 | 67 | 264.1 | 39.2 |
| 28 | 27.7 | 4.1 | 88 | 87.0 | 12.9 | 48 | 146.4 | 21.7 | 08 | 205.7 | 30.5 | 68 | 265.1 | 39.3 |
| 29 | 28.7 | 4.3 | 89 | 88.0 | 13.1 | 49 | 147.4 | 21.9 | 09 | 206.7 | 30.7 | 69 | 266.1 | 39.5 |
| 30 | 29.7 | 4.4 | 90 | 89.0 | 13.2 | 50 | 148.4 | 22.0 | 10 | 207.7 | 30.8 | 70 | 267.1 | 39.6 |
| 31 | 30.7 | 4.5 | 91 | 90.0 | 13.4 | 151 | 149.4 | 22.2 | 211 | 208.7 | 31.0 | 271 | 268.1 | 39.8 |
| 32 | 31.7 | 4.7 | 92 | 91.0 | 13.5 | 52 | 150.4 | 22.3 | 12 | 209.7 | 31.1 | 72 | 269.1 | 39.9 |
| 33 | 32.6 | 4.8 | 93 | 92.0 | 13.6 | 53 | 151.3 | 22.4 | 13 | 210.7 | 31.3 | 73 | 270.0 | 40.1 |
| 34 | 33.6 | 5.0 | 94 | 93.0 | 13.8 | 54 | 152.3 | 22.6 | 14 | 211.7 | 31.4 | 74 | 271.0 | 40.2 |
| 35 | 34.6 | 5.1 | 95 | 94.0 | 13.9 | 55 | 153.3 | 22.7 | 15 | 212.7 | 31.5 | 75 | 272.0 | 40.4 |
| 36 | 35.6 | 5.3 | 96 | 95.0 | 14.1 | 56 | 154.3 | 22.9 | 16 | 213.7 | 31.7 | 76 | 273.0 | 40.5 |
| 37 | 36.6 | 5.4 | 97 | 96.0 | 14.2 | 57 | 155.3 | 23.0 | 17 | 214.7 | 31.8 | 77 | 274.0 | 40.6 |
| 38 | 37.6 | 5.6 | 98 | 96.9 | 14.4 | 58 | 156.3 | 23.2 | 18 | 215.6 | 32.0 | 78 | 275.0 | 40.8 |
| 39 | 38.6 | 5.7 | 99 | 97.9 | 14.5 | 59 | 157.3 | 23.3 | 19 | 216.6 | 32.1 | 79 | 276.0 | 40.9 |
| 40 | 39.6 | 5.9 | 100 | 98.9 | 14.7 | 60 | 158.3 | 23.5 | 20 | 217.6 | 32.3 | 80 | 277.0 | 41.1 |
| 41 | 40.6 | 6.0 | 101 | 99.9 | 14.8 | 161 | 159.3 | 23.6 | 221 | 218.6 | 32.4 | 281 | 278.0 | 41.2 |
| 42 | 41.5 | 6.2 | 02 | 100.9 | 15.0 | 62 | 160.2 | 23.8 | 22 | 219.6 | 32.6 | 82 | 278.9 | 41.4 |
| 43 | 42.5 | 6.3 | 03 | 101.9 | 15.1 | 63 | 161.2 | 23.9 | 23 | 220.6 | 32.7 | 83 | 279.9 | 41.5 |
| 44 | 43.5 | 6.5 | 04 | 102.9 | 15.3 | 64 | 162.2 | 24.1 | 24 | 221.6 | 32.9 | 84 | 280.9 | 41.7 |
| 45 | 44.5 | 6.6 | 05 | 103.9 | 15.4 | 65 | 163.2 | 24.2 | 25 | 222.6 | 33.0 | 85 | 281.9 | 41.8 |
| 46 | 45.5 | 6.7 | 06 | 104.9 | 15.6 | 66 | 164.2 | 24.4 | 26 | 223.6 | 33.2 | 86 | 282.9 | 42.0 |
| 47 | 46.5 | 6.9 | 07 | 105.8 | 15.7 | 67 | 165.2 | 24.5 | 27 | 224.5 | 33.3 | 87 | 283.9 | 42.1 |
| 48 | 47.5 | 7.0 | 08 | 106.8 | 15.8 | 68 | 166.2 | 24.7 | 28 | 225.5 | 33.5 | 88 | 284.9 | 42.3 |
| 49 | 48.5 | 7.2 | 09 | 107.8 | 16.0 | 69 | 167.2 | 24.8 | 29 | 226.5 | 33.6 | 89 | 285.9 | 42.4 |
| 50 | 49.5 | 7.3 | 10 | 108.8 | 16.1 | 70 | 168.2 | 24.9 | 30 | 227.5 | 33.7 | 90 | 286.9 | 42.6 |
| 51 | 50.4 | 7.5 | 111 | 109.8 | 16.3 | 171 | 169.1 | 25.1 | 231 | 228.5 | 33.9 | 291 | 287.9 | 42.7 |
| 52 | 51.4 | 7.6 | 12 | 110.8 | 16.4 | 72 | 170.1 | 25.2 | 32 | 229.5 | 34.0 | 92 | 288.8 | 42.8 |
| 53 | 52.4 | 7.8 | 13 | 111.8 | 16.6 | 73 | 171.1 | 25.4 | 33 | 230.5 | 34.2 | 93 | 289.8 | 43.0 |
| 54 | 53.4 | 7.9 | 14 | 112.8 | 16.7 | 74 | 172.1 | 25.5 | 34 | 231.5 | 34.3 | 94 | 290.8 | 43.1 |
| 55 | 54.4 | 8.1 | 15 | 113.8 | 16.9 | 75 | 173.1 | 25.7 | 35 | 232.5 | 34.5 | 95 | 291.8 | 43.3 |
| 56 | 55.4 | 8.2 | 16 | 114.7 | 17.0 | 76 | 174.1 | 25.8 | 36 | 233.4 | 34.6 | 96 | 292.8 | 43.4 |
| 57 | 56.4 | 8.4 | 17 | 115.7 | 17.2 | 77 | 175.1 | 26.0 | 37 | 234.4 | 34.8 | 97 | 293.8 | 43.6 |
| 58 | 57.4 | 8.5 | 18 | 116.7 | 17.3 | 78 | 176.1 | 26.1 | 38 | 235.4 | 34.9 | 98 | 294.8 | 43.7 |
| 59 | 58.4 | 8.7 | 19 | 117.7 | 17.5 | 79 | 177.1 | 26.3 | 39 | 236.4 | 35.1 | 99 | 295.8 | 43.9 |
| 60 | 59.4 | 8.8 | 20 | 118.7 | 17.6 | 80 | 178.1 | 26.4 | 40 | 237.4 | 35.2 | 300 | 296.8 | 44.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| E. ¾ N. | E. ¾ S. | W. ¾ N. | W. ¾ S. | [For 7¼ Points. |

TABLE 1. [Page 355

Difference of Latitude and Departure for 1 Point.

| | N. by E. | | | N. by W. | | | S. by E. | | | S. by W. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 1.0 | 0.2 | 61 | 59.8 | 11.9 | 121 | 118.7 | 23.6 | 181 | 177.5 | 35.3 | 241 | 236.4 | 47.0 |
| 2 | 2.0 | 0.4 | 62 | 60.8 | 12.1 | 22 | 119.7 | 23.8 | 82 | 178.5 | 35.5 | 42 | 237.4 | 47.2 |
| 3 | 2.9 | 0.6 | 63 | 61.8 | 12.3 | 23 | 120.6 | 24.0 | 83 | 179.5 | 35.7 | 43 | 238.3 | 47.4 |
| 4 | 3.9 | 0.8 | 64 | 62.8 | 12.5 | 24 | 121.6 | 24.2 | 84 | 180.5 | 35.9 | 44 | 239.3 | 47.6 |
| 5 | 4.9 | 1.0 | 65 | 63.8 | 12.7 | 25 | 122.6 | 24.4 | 85 | 181.4 | 36.1 | 45 | 240.3 | 47.8 |
| 6 | 5.9 | 1.2 | 66 | 64.7 | 12.9 | 26 | 123.6 | 24.6 | 86 | 182.4 | 36.3 | 46 | 241.3 | 48.0 |
| 7 | 6.9 | 1.4 | 67 | 65.7 | 13.1 | 27 | 124.6 | 24.8 | 87 | 183.4 | 36.5 | 47 | 242.3 | 48.2 |
| 8 | 7.8 | 1.6 | 68 | 66.7 | 13.3 | 28 | 125.5 | 25.0 | 88 | 184.4 | 36.7 | 48 | 243.2 | 48.4 |
| 9 | 8.8 | 1.8 | 69 | 67.7 | 13.5 | 29 | 126.5 | 25.2 | 89 | 185.4 | 36.9 | 49 | 244.2 | 48.6 |
| 10 | 9.8 | 2.0 | 70 | 68.7 | 13.7 | 30 | 127.5 | 25.4 | 90 | 186.3 | 37.1 | 50 | 245.2 | 48.8 |
| 11 | 10.8 | 2.1 | 71 | 69.6 | 13.9 | 131 | 128.5 | 25.6 | 191 | 187.3 | 37.3 | 251 | 246.2 | 49.0 |
| 12 | 11.8 | 2.3 | 72 | 70.6 | 14.0 | 32 | 129.5 | 25.8 | 92 | 188.3 | 37.5 | 52 | 247.2 | 49.2 |
| 13 | 12.8 | 2.5 | 73 | 71.6 | 14.2 | 33 | 130.4 | 25.9 | 93 | 189.3 | 37.7 | 53 | 248.1 | 49.4 |
| 14 | 13.7 | 2.7 | 74 | 72.6 | 14.4 | 34 | 131.4 | 26.1 | 94 | 190.3 | 37.8 | 54 | 249.1 | 49.6 |
| 15 | 14.7 | 2.9 | 75 | 73.6 | 14.6 | 35 | 132.4 | 26.3 | 95 | 191.3 | 38.0 | 55 | 250.1 | 49.7 |
| 16 | 15.7 | 3.1 | 76 | 74.5 | 14.8 | 36 | 133.4 | 26.5 | 96 | 192.2 | 38.2 | 56 | 251.1 | 49.9 |
| 17 | 16.7 | 3.3 | 77 | 75.5 | 15.0 | 37 | 134.4 | 26.7 | 97 | 193.2 | 38.4 | 57 | 252.1 | 50.1 |
| 18 | 17.7 | 3.5 | 78 | 76.5 | 15.2 | 38 | 135.3 | 26.9 | 98 | 194.2 | 38.6 | 58 | 253.0 | 50.3 |
| 19 | 18.6 | 3.7 | 79 | 77.5 | 15.4 | 39 | 136.3 | 27.1 | 99 | 195.2 | 38.8 | 59 | 254.0 | 50.5 |
| 20 | 19.6 | 3.9 | 80 | 78.5 | 15.6 | 40 | 137.3 | 27.3 | 200 | 196.2 | 39.0 | 60 | 255.0 | 50.7 |
| 21 | 20.6 | 4.1 | 81 | 79.4 | 15.8 | 141 | 138.3 | 27.5 | 201 | 197.1 | 39.2 | 261 | 256.0 | 50.9 |
| 22 | 21.6 | 4.3 | 82 | 80.4 | 16.0 | 42 | 139.3 | 27.7 | 02 | 198.1 | 39.4 | 62 | 257.0 | 51.1 |
| 23 | 22.6 | 4.5 | 83 | 81.4 | 16.2 | 43 | 140.3 | 27.9 | 03 | 199.1 | 39.6 | 63 | 257.9 | 51.3 |
| 24 | 23.5 | 4.7 | 84 | 82.4 | 16.4 | 44 | 141.2 | 28.1 | 04 | 200.1 | 39.8 | 64 | 258.9 | 51.5 |
| 25 | 24.5 | 4.9 | 85 | 83.4 | 16.6 | 45 | 142.2 | 28.3 | 05 | 201.1 | 40.0 | 65 | 259.9 | 51.7 |
| 26 | 25.5 | 5.1 | 86 | 84.3 | 16.8 | 46 | 143.2 | 28.5 | 06 | 202.0 | 40.2 | 66 | 260.9 | 51.9 |
| 27 | 26.5 | 5.3 | 87 | 85.3 | 17.0 | 47 | 144.2 | 28.7 | 07 | 203.0 | 40.4 | 67 | 261.9 | 52.1 |
| 28 | 27.5 | 5.5 | 88 | 86.3 | 17.2 | 48 | 145.2 | 28.9 | 08 | 204.0 | 40.6 | 68 | 262.9 | 52.3 |
| 29 | 28.4 | 5.7 | 89 | 87.3 | 17.4 | 49 | 146.1 | 29.1 | 09 | 205.0 | 40.8 | 69 | 263.8 | 52.5 |
| 30 | 29.4 | 5.9 | 90 | 88.3 | 17.6 | 50 | 147.1 | 29.3 | 10 | 206.0 | 41.0 | 70 | 264.8 | 52.7 |
| 31 | 30.4 | 6.0 | 91 | 89.3 | 17.8 | 151 | 148.1 | 29.5 | 211 | 206.9 | 41.2 | 271 | 265.8 | 52.9 |
| 32 | 31.4 | 6.2 | 92 | 90.2 | 17.9 | 52 | 149.1 | 29.7 | 12 | 207.9 | 41.4 | 72 | 266.8 | 53.1 |
| 33 | 32.4 | 6.4 | 93 | 91.2 | 18.1 | 53 | 150.1 | 29.8 | 13 | 208.9 | 41.6 | 73 | 267.8 | 53.3 |
| 34 | 33.3 | 6.6 | 94 | 92.2 | 18.3 | 54 | 151.0 | 30.0 | 14 | 209.9 | 41.7 | 74 | 268.7 | 53.5 |
| 35 | 34.3 | 6.8 | 95 | 93.2 | 18.5 | 55 | 152.0 | 30.2 | 15 | 210.9 | 41.9 | 75 | 269.7 | 53.6 |
| 36 | 35.3 | 7.0 | 96 | 94.2 | 18.7 | 56 | 153.0 | 30.4 | 16 | 211.8 | 42.1 | 76 | 270.7 | 53.8 |
| 37 | 36.3 | 7.2 | 97 | 95.1 | 18.9 | 57 | 154.0 | 30.6 | 17 | 212.8 | 42.3 | 77 | 271.7 | 54.0 |
| 38 | 37.3 | 7.4 | 98 | 96.1 | 19.1 | 58 | 155.0 | 30.8 | 18 | 213.8 | 42.5 | 78 | 272.7 | 54.2 |
| 39 | 38.3 | 7.6 | 99 | 97.1 | 19.3 | 59 | 155.9 | 31.0 | 19 | 214.8 | 42.7 | 79 | 273.6 | 54.4 |
| 40 | 39.2 | 7.8 | 100 | 98.1 | 19.5 | 60 | 156.9 | 31.2 | 20 | 215.8 | 42.9 | 80 | 274.6 | 54.6 |
| 41 | 40.2 | 8.0 | 101 | 99.1 | 19.7 | 161 | 157.9 | 31.4 | 221 | 216.8 | 43.1 | 281 | 275.6 | 54.8 |
| 42 | 41.2 | 8.2 | 02 | 100.0 | 19.9 | 62 | 158.9 | 31.6 | 22 | 217.7 | 43.3 | 82 | 276.6 | 55.0 |
| 43 | 42.2 | 8.4 | 03 | 101.0 | 20.1 | 63 | 159.9 | 31.8 | 23 | 218.7 | 43.5 | 83 | 277.6 | 55.2 |
| 44 | 43.2 | 8.6 | 04 | 102.0 | 20.3 | 64 | 160.8 | 32.0 | 24 | 219.7 | 43.7 | 84 | 278.5 | 55.4 |
| 45 | 44.1 | 8.8 | 05 | 103.0 | 20.5 | 65 | 161.8 | 32.2 | 25 | 220.7 | 43.9 | 85 | 279.5 | 55.6 |
| 46 | 45.1 | 9.0 | 06 | 104.0 | 20.7 | 66 | 162.8 | 32.4 | 26 | 221.7 | 44.1 | 86 | 280.5 | 55.8 |
| 47 | 46.1 | 9.2 | 07 | 104.9 | 20.9 | 67 | 163.8 | 32.6 | 27 | 222.6 | 44.3 | 87 | 281.5 | 56.0 |
| 48 | 47.1 | 9.4 | 08 | 105.9 | 21.1 | 68 | 164.8 | 32.8 | 28 | 223.6 | 44.5 | 88 | 282.5 | 56.2 |
| 49 | 48.1 | 9.6 | 09 | 106.9 | 21.3 | 69 | 165.8 | 33.0 | 29 | 224.6 | 44.7 | 89 | 283.4 | 56.4 |
| 50 | 49.0 | 9.8 | 10 | 107.9 | 21.5 | 70 | 166.7 | 33.2 | 30 | 225.6 | 44.9 | 90 | 284.4 | 56.6 |
| 51 | 50.0 | 9.9 | 111 | 108.9 | 21.7 | 171 | 167.7 | 33.4 | 231 | 226.6 | 45.1 | 291 | 285.4 | 56.8 |
| 52 | 51.0 | 10.1 | 12 | 109.9 | 21.9 | 72 | 168.7 | 33.6 | 32 | 227.5 | 45.3 | 92 | 286.4 | 57.0 |
| 53 | 52.0 | 10.3 | 13 | 110.8 | 22.0 | 73 | 169.7 | 33.8 | 33 | 228.5 | 45.5 | 93 | 287.4 | 57.2 |
| 54 | 53.0 | 10.5 | 14 | 111.8 | 22.2 | 74 | 170.7 | 33.9 | 34 | 229.5 | 45.7 | 94 | 288.4 | 57.4 |
| 55 | 53.9 | 10.7 | 15 | 112.8 | 22.4 | 75 | 171.6 | 34.1 | 35 | 230.5 | 45.8 | 95 | 289.3 | 57.6 |
| 56 | 54.9 | 10.9 | 16 | 113.8 | 22.6 | 76 | 172.6 | 34.3 | 36 | 231.5 | 46.0 | 96 | 290.3 | 57.7 |
| 57 | 55.9 | 11.1 | 17 | 114.8 | 22.8 | 77 | 173.6 | 34.5 | 37 | 232.4 | 46.2 | 97 | 291.3 | 57.9 |
| 58 | 56.9 | 11.3 | 18 | 115.7 | 23.0 | 78 | 174.6 | 34.7 | 38 | 233.4 | 46.4 | 98 | 292.3 | 58.1 |
| 59 | 57.9 | 11.5 | 19 | 116.7 | 23.2 | 79 | 175.6 | 34.9 | 39 | 234.4 | 46.6 | 99 | 293.3 | 58.3 |
| 60 | 58.8 | 11.7 | 20 | 117.7 | 23.4 | 80 | 176.5 | 35.1 | 40 | 235.4 | 46.8 | 300 | 294.2 | 58.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |
| | E. by N. | | | E. by S. | | | W. by N. | | | W. by S. | | | [For 7 points. | |

# TABLE 1.

Difference of Latitude and Departure for 1¼ Points.

| | N. by E. ¼ E. | | | N. by W. ¼ W. | | | S. by E. ¼ E. | | | S. by W. ¼ W. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 1.0 | 0.2 | 61 | 59.2 | 14.8 | 121 | 117.4 | 29.4 | 181 | 175.6 | 44.0 | 241 | 233.8 | 58.6 |
| 2 | 1.9 | 0.5 | 62 | 60.1 | 15.1 | 22 | 118.3 | 29.6 | 82 | 176.5 | 44.2 | 42 | 234.7 | 58.8 |
| 3 | 2.9 | 0.7 | 63 | 61.1 | 15.3 | 23 | 119.3 | 29.9 | 83 | 177.5 | 44.5 | 43 | 235.7 | 59.0 |
| 4 | 3.9 | 1.0 | 64 | 62.1 | 15.6 | 24 | 120.3 | 30.1 | 84 | 178.5 | 44.7 | 44 | 236.7 | 59.3 |
| 5 | 4.9 | 1.2 | 65 | 63.1 | 15.8 | 25 | 121.3 | 30.4 | 85 | 179.5 | 45.0 | 45 | 237.7 | 59.5 |
| 6 | 5.8 | 1.5 | 66 | 64.0 | 16.0 | 26 | 122.2 | 30.6 | 86 | 180.4 | 45.2 | 46 | 238.6 | 59.8 |
| 7 | 6.8 | 1.7 | 67 | 65.0 | 16.3 | 27 | 123.2 | 30.9 | 87 | 181.4 | 45.4 | 47 | 239.6 | 60.0 |
| 8 | 7.8 | 1.9 | 68 | 66.0 | 16.5 | 28 | 124.2 | 31.1 | 88 | 182.4 | 45.7 | 48 | 240.6 | 60.3 |
| 9 | 8.7 | 2.2 | 69 | 66.9 | 16.8 | 29 | 125.1 | 31.3 | 89 | 183.3 | 45.9 | 49 | 241.5 | 60.5 |
| 10 | 9.7 | 2.4 | 70 | 67.9 | 17.0 | 30 | 126.1 | 31.6 | ·90 | 184.3 | 46.2 | 50 | 242.5 | 60.7 |
| 11 | 10.7 | 2.7 | 71 | 68.9 | 17.3 | 131 | 127.1 | 31.8 | 191 | 185.3 | 46.4 | 251 | 243.5 | 61.0 |
| 12 | 11.6 | 2.9 | 72 | 69.8 | 17.5 | 32 | 128.0 | 32.1 | 92 | 186.2 | 46.7 | 52 | 244.4 | 61.2 |
| 13 | 12.6 | 3.2 | 73 | 70.8 | 17.7 | 33 | 129.0 | 32.3 | 93 | 187.2 | 46.9 | 53 | 245.4 | 61.5 |
| 14 | 13.6 | 3.4 | 74 | 71.8 | 18.0 | 34 | 130.0 | 32.6 | 94 | 188.2 | 47.1 | 54 | 246.4 | 61.7 |
| 15 | 14.6 | 3.6 | 75 | 72.8 | 18.2 | 35 | 131.0 | 32.8 | 95 | 189.2 | 47.4 | 55 | 247.4 | 62.0 |
| 16 | 15.5 | 3.9 | 76 | 73.7 | 18.5 | 36 | 131.9 | 33.0 | 96 | 190.1 | 47.6 | 56 | 248.3 | 62.2 |
| 17 | 16.5 | 4.1 | 77 | 74.7 | 18.7 | 37 | 132.9 | 33.3 | 97 | 191.1 | 47.9 | 57 | 249.3 | 62.4 |
| 18 | 17.5 | 4.4 | 78 | 75.7 | 19.0 | 38 | 133.9 | 33.5 | 98 | 192.1 | 48.1 | 58 | 250.3 | 62.7 |
| 19 | 18.4 | 4.6 | 79 | 76.6 | 19.2 | 39 | 134.8 | 33.8 | 99 | 193.0 | 48.4 | 59 | 251.2 | 62.9 |
| 20 | 19.4 | 4.9 | 80 | 77.6 | 19.4 | 40 | 135.8 | 34.0 | 200 | 194.0 | 48.6 | 60 | 252.2 | 63.2 |
| 21 | 20.4 | 5.1 | 81 | 78.6 | 19.7 | 141 | 136.8 | 34.3 | 201 | 195.0 | 48.8 | 261 | 253.2 | 63.4 |
| 22 | 21.3 | 5.3 | 82 | 79.5 | 19.9 | 42 | 137.7 | 34.5 | 02 | 195.9 | 49.1 | 62 | 254.1 | 63.7 |
| 23 | 22.3 | 5.6 | 83 | 80.5 | 20.2 | 43 | 138.7 | 34.7 | 03 | 196.9 | 49.3 | 63 | 255.1 | 63.9 |
| 24 | 23.3 | 5.8 | 84 | 81.5 | 20.4 | 44 | 139.7 | 35.0 | 04 | 197.9 | 49.6 | 64 | 256.1 | 64.1 |
| 25 | 24.3 | 6.1 | 85 | 82.5 | 20.7 | 45 | 140.7 | 35.2 | 05 | 198.9 | 49.8 | 65 | 257.1 | 64.4 |
| 26 | 25.2 | 6.3 | 86 | 83.4 | 20.9 | 46 | 141.6 | 35.5 | 06 | 199.8 | 50.1 | 66 | 258.0 | 64.6 |
| 27 | 26.2 | 6.6 | 87 | 84.4 | 21.1 | 47 | 142.6 | 35.7 | 07 | 200.8 | 50.3 | 67 | 259.0 | 64.9 |
| 28 | 27.2 | 6.8 | 88 | 85.4 | 21.4 | 48 | 143.6 | 36.0 | 08 | 201.8 | 50.5 | 68 | 260.0 | 65.1 |
| 29 | 28.1 | 7.0 | 89 | 86.3 | 21.6 | 49 | 144.5 | 36.2 | 09 | 202.7 | 50.8 | 69 | 260.9 | 65.4 |
| 30 | 29.1 | 7.3 | 90 | 87.3 | 21.9 | 50 | 145.5 | 36.4 | 10 | 203.7 | 51.0 | 70 | 261.9 | 65.6 |
| 31 | 30.1 | 7.5 | 91 | 88.3 | 22.1 | 151 | 146.5 | 36.7 | 211 | 204.7 | 51.3 | 271 | 262.9 | 65.8 |
| 32 | 31.0 | 7.8 | 92 | 89.2 | 22.4 | 52 | 147.4 | 36.9 | 12 | 205.6 | 51.5 | 72 | 263.8 | 66.1 |
| 33 | 32.0 | 8.0 | 93 | 90.2 | 22.6 | 53 | 148.4 | 37.2 | 13 | 206.6 | 51.8 | 73 | 264.8 | 66.3 |
| 34 | 33.0 | 8.3 | 94 | 91.2 | 22.8 | 54 | 149.4 | 37.4 | 14 | 207.6 | 52.0 | 74 | 265.8 | 66.6 |
| 35 | 34.0 | 8.5 | 95 | 92.2 | 23.1 | 55 | 150.4 | 37.7 | 15 | 208.6 | 52.2 | 75 | 266.8 | 66.8 |
| 36 | 34.9 | 8.7 | 96 | 93.1 | 23.3 | 56 | 151.3 | 37.9 | 16 | 209.5 | 52.5 | 76 | 267.7 | 67.1 |
| 37 | 35.9 | 9.0 | 97 | 94.1 | 23.6 | 57 | 152.3 | 38.1 | 17 | 210.5 | 52.7 | 77 | 268.7 | 67.3 |
| 38 | 36.9 | 9.2 | 98 | 95.1 | 23.8 | 58 | 153.3 | 38.4 | 18 | 211.5 | 53.0 | 78 | 269.7 | 67.5 |
| 39 | 37.8 | 9.5 | 99 | 96.0 | 24.1 | 59 | 154.2 | 38.6 | 19 | 212.4 | 53.2 | 79 | 270.6 | 67.8 |
| 40 | 38.8 | 9.7 | 100 | 97.0 | 24.3 | 60 | 155.2 | 38.9 | 20 | 213.4 | 53.5 | 80 | 271.6 | 68.0 |
| 41 | 39.8 | 10.0 | 101 | 98.0 | 24.5 | 161 | 156.2 | 39.1 | 221 | 214.4 | 53.7 | 281 | 272.6 | 68.3 |
| 42 | 40.7 | 10.2 | 02 | 98.9 | 24.8 | 62 | 157.1 | 39.4 | 22 | 215.3 | 53.9 | 82 | 273.5 | 68.5 |
| 43 | 41.7 | 10.4 | 03 | 99.9 | 25.0 | 63 | 158.1 | 39.6 | 23 | 216.3 | 54.2 | 83 | 274.5 | 68.8 |
| 44 | 42.7 | 10.7 | 04 | 100.9 | 25.3 | 64 | 159.1 | 39.8 | 24 | 217.3 | 54.4 | 84 | 275.5 | 69.0 |
| 45 | 43.7 | 10.9 | 05 | 101.9 | 25.5 | 65 | 160.1 | 40.1 | 25 | 218.3 | 54.7 | 85 | 277.5 | 69.2 |
| 46 | 44.6 | 11.2 | 06 | 102.8 | 25.8 | 66 | 161.0 | 40.3 | 26 | 219.2 | 54.9 | 86 | 277.4 | 69.5 |
| 47 | 45.6 | 11.4 | 07 | 103.8 | 26.0 | 67 | 162.0 | 40.6 | 27 | 220.2 | 55.2 | 87 | 278.4 | 69.7 |
| 48 | 46.6 | 11.7 | 08 | 104.8 | 26.2 | 68 | 163.0 | 40.8 | 28 | 221.2 | 55.4 | 88 | 279.4 | 70.0 |
| 49 | 47.5 | 11.9 | 09 | 105.7 | 26.5 | 69 | 163.9 | 41.1 | 29 | 222.1 | 55.6 | 89 | 280.3 | 70.2 |
| 50 | 48.5 | 12.1 | 10 | 106.7 | 26.7 | 70 | 164.9 | 41.3 | 30 | 223.1 | 55.9 | 90 | 281.3 | 70.5 |
| 51 | 49.5 | 12.4 | 111 | 107.7 | 27.0 | 171 | 165.9 | 41.5 | 231 | 224.1 | 56.1 | 291 | 282.3 | 70.7 |
| 52 | 50.4 | 12.6 | 12 | 108.6 | 27.2 | 72 | 166.8 | 41.8 | 32 | 225.0 | 56.4 | 92 | 283.2 | 71.0 |
| 53 | 51.4 | 12.9 | 13 | 109.6 | 27.5 | 73 | 167.8 | 42.0 | 33 | 226.0 | 56.6 | 93 | 284.2 | 71.2 |
| 54 | 52.4 | 13.1 | 14 | 110.6 | 27.7 | 74 | 168.8 | 42.3 | 34 | 227.0 | 56.9 | 94 | 285.2 | 71.4 |
| 55 | 53.4 | 13.4 | 15 | 111.6 | 27.9 | 75 | 169.8 | 42.5 | 35 | 228.0 | 57.1 | 95 | 286.2 | 71.7 |
| 56 | 54.3 | 13.6 | 16 | 112.5 | 28.2 | 76 | 170.7 | 42.8 | 36 | 228.9 | 57.3 | 96 | 287.1 | 71.9 |
| 57 | 55.3 | 13.8 | 17 | 113.5 | 28.4 | 77 | 171.7 | 43.0 | 37 | 229.9 | 57.6 | 97 | 288.1 | 72.2 |
| 58 | 56.3 | 14.1 | 18 | 114.5 | 28.7 | 78 | 172.7 | 43.3 | 38 | 230.9 | 57.8 | 98 | 289.1 | 72.4 |
| 59 | 57.2 | 14.3 | 19 | 115.4 | 28.9 | 79 | 173.6 | 43.5 | 39 | 231.8 | 58.1 | 99 | 290.9 | 72.7 |
| 60 | 58.2 | 14.6 | 20 | 116.4 | 29.2 | 80 | 174.6 | 43.7 | 40 | 232.8 | 58.3 | 300 | 291.0 | 72.9 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| ENE. ¾ E. | ESE. ¾ E. | WNW. ¾ W. | WSW. ¾ W. | [For 6¾ Points. |
|---|---|---|---|---|

TABLE 1. [Page 357

Difference of Latitude and Departure for 1½ Points.

| | N. by E. ½ E. | | | N. by W. ½ W. | | | S. by E. ½ E. | | | S. by W. ½ W. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 1.0 | 0.3 | 61 | 58.4 | 17.7 | 121 | 115.8 | 35.1 | 181 | 173.2 | 52.5 | 241 | 230.6 | 70.0 |
| 2 | 1.9 | 0.6 | 62 | 59.3 | 18.0 | 22 | 116.7 | 35.4 | 82 | 174.2 | 52.8 | 42 | 231.6 | 70.2 |
| 3 | 2.9 | 0.9 | 63 | 60.3 | 18.3 | 23 | 117.7 | 35.7 | 83 | 175.1 | 53.1 | 43 | 232.5 | 70.5 |
| 4 | 3.8 | 1.2 | 64 | 61.2 | 18.6 | 24 | 118.7 | 36.0 | 84 | 176.1 | 53.4 | 44 | 233.5 | 70.8 |
| 5 | 4.8 | 1.5 | 65 | 62.2 | 18.9 | 25 | 119.6 | 36.3 | 85 | 177.0 | 53.7 | 45 | 234.5 | 71.1 |
| 6 | 5.7 | 1.7 | 66 | 63.2 | 19.2 | 26 | 120.6 | 36.6 | 86 | 178.0 | 54.0 | 46 | 235.4 | 71,4 |
| 7 | 6.7 | 2.0 | 67 | 64.1 | 19.4 | 27 | 121.5 | 36.9 | 87 | 178.9 | 54.3 | 47 | 236.4 | 71.7 |
| 8 | 7.7 | 2.3 | 68 | 65.1 | 19.7 | 28 | 122.5 | 37.2 | 88 | 179.9 | 54.6 | 48 | 237.3 | 72.0 |
| 9 | 8.6 | 2.6 | 69 | 66.0 | 20.0 | 29 | 123.4 | 37.4 | 89 | 180.9 | 54.9 | 49 | 238.3 | 72.3 |
| 10 | 9.6 | 2.9 | 70 | 67.0 | 20.3 | 30 | 124.4 | 37.7 | 90 | 181.8 | 55.2 | 50 | 239.2 | 72.6 |
| 11 | 10.5 | 3.2 | 71 | 67.9 | 20.6 | 131 | 125.4 | 38.0 | 191 | 182.8 | 55.4 | 251 | 240.2 | 72.9 |
| 12 | 11.5 | 3.5 | 72 | 68.9 | 20.9 | 32 | 126.3 | 38.3 | 92 | 183.7 | 55.7 | 52 | 241.1 | 73.2 |
| 13 | 12.4 | 3.8 | 73 | 69.9 | 21.2 | 33 | 127.3 | 38.6 | 93 | 184.7 | 56.0 | 53 | 242.1 | 73.4 |
| 14 | 13.4 | 4.1 | 74 | 70.8 | 21.5 | 34 | 128.2 | 38.9 | 94 | 185.6 | 56.3 | 54 | 243.1 | 73.7 |
| 15 | 14.4 | 4.4 | 75 | 71.8 | 21.8 | 35 | 129.2 | 39.2 | 95 | 186.6 | 56.6 | 55 | 244.0 | 74.0 |
| 16 | 15.3 | 4.6 | 76 | 72.7 | 22.1 | 36 | 130.1 | 39.5 | 96 | 187.6 | 56.9 | 56 | 245.0 | 74.3 |
| 17 | 16.3 | 4.9 | 77 | 73.7 | 22.4 | 37 | 131.1 | 39.8 | 97 | 188.5 | 57.2 | 57 | 245.9 | 74.6 |
| 18 | 17.2 | 5.2 | 78 | 74.6 | 22.6 | 38 | 132.1 | 40.1 | 98 | 189.5 | 57.5 | 58 | 246.9 | 74.9 |
| 19 | 18.2 | 5.5 | 79 | 75.6 | 22.9 | 39 | 133.0 | 40.3 | 99 | 190.4 | 57.8 | 59 | 247.8 | 75.2 |
| 20 | 19.1 | 5.8 | 80 | 76.6 | 23.2 | 40 | 134.0 | 40.6 | 200 | 191.4 | 58.1 | 60 | 248.8 | 75.5 |
| 21 | 20.1 | 6.1 | 81 | 77.5 | 23.5 | 141 | 134.9 | 40.9 | 201 | 192.3 | 58.3 | 261 | 249.8 | 75.8 |
| 22 | 21.1 | 6.4 | 82 | 78.5 | 23.8 | 42 | 135.9 | 41.2 | 02 | 193.3 | 58.6 | 62 | 250.7 | 76.1 |
| 23 | 22.0 | 6.7 | 83 | 79.4 | 24.1 | 43 | 136.8 | 41.5 | 03 | 194.3 | 58.9 | 63 | 251.7 | 76.3 |
| 24 | 23.0 | 7.0 | 84 | 80.4 | 24.4 | 44 | 137.8 | 41.8 | 04 | 195.2 | 59.2 | 64 | 252.6 | 76.6 |
| 25 | 23.9 | 7.3 | 85 | 81.3 | 24.7 | 45 | 138.8 | 42.1 | 05 | 196.2 | 59.5 | 65 | 253.6 | 76.9 |
| 26 | 24.9 | 7.5 | 86 | 82.3 | 25.0 | 46 | 139.7 | 42.4 | 06 | 197.1 | 59.8 | 66 | 254.5 | 77.2 |
| 27 | 25.8 | 7.8 | 87 | 83.3 | 25.3 | 47 | 140.7 | 42.7 | 07 | 198.1 | 60.1 | 67 | 255.5 | 77.5 |
| 28 | 26.8 | 8.1 | 88 | 84.2 | 25.5 | 48 | 141.6 | 43.0 | 08 | 199.0 | 60.4 | 68 | 256.5 | 77.8 |
| 29 | 27.8 | 8.4 | 89 | 85.2 | 25.8 | 49 | 142.6 | 43.3 | 09 | 200.0 | 60.7 | 69 | 257.4 | 78.1 |
| 30 | 28.7 | 8.7 | 90 | 86.1 | 26.1 | 50 | 143.5 | 43.5 | 10 | 201.0 | 61.0 | 70 | 258.4 | 78.4 |
| 31 | 29.7 | 9.0 | 91 | 87.1 | 26.4 | 151 | 144.5 | 43.8 | 211 | 201.9 | 61.3 | 271 | 259.3 | 78.7 |
| 32 | 30.6 | 9.3 | 92 | 88.0 | 26.7 | 52 | 145.5 | 44.1 | 12 | 202.9 | 61.5 | 72 | 260.3 | 79.0 |
| 33 | 31.6 | 9.6 | 93 | 89.0 | 27.0 | 53 | 146.4 | 44.4 | 13 | 203.8 | 61.8 | 73 | 261.2 | 79.2 |
| 34 | 32.5 | 9.9 | 94 | 90.0 | 27.3 | 54 | 147.4 | 44.7 | 14 | 204.8 | 62.1 | 74 | 262.2 | 79.5 |
| 35 | 33.5 | 10.2 | 95 | 90.9 | 27.6 | 55 | 148.3 | 45.0 | 15 | 205.7 | 62.4 | 75 | 263.2 | 79.8 |
| 36 | 34.4 | 10.5 | 96 | 91.9 | 27.9 | 56 | 149.3 | 45.3 | 16 | 206.7 | 62.7 | 76 | 264.1 | 80.1 |
| 37 | 35.4 | 10.7 | 97 | 92.8 | 28.2 | 57 | 150.2 | 45.6 | 17 | 207.7 | 63.0 | 77 | 265.1 | 80.4 |
| 38 | 36.4 | 11.0 | 98 | 93.8 | 28.4 | 58 | 151.2 | 45.9 | 18 | 208.6 | 63.3 | 78 | 266.0 | 80.7 |
| 39 | 37.3 | 11.3 | 99 | 94.7 | 28.7 | 59 | 152.2 | 46.2 | 19 | 209.6 | 63.6 | 79 | 267.0 | 81.0 |
| 40 | 38.3 | 11.6 | 100 | 95.7 | 29.0 | 60 | 153.1 | 46.4 | 20 | 210.5 | 63.9 | 80 | 267.9 | 81.3 |
| 41 | 39.2 | 11.9 | 101 | 96.7 | 29.3 | 161 | 154.1 | 46.7 | 221 | 211.5 | 64.2 | 281 | 268.9 | 81.6 |
| 42 | 40.2 | 12.2 | 02 | 97.6 | 29.6 | 62 | 155.0 | 47.0 | 22 | 212.4 | 64.4 | 82 | 269.9 | 81.9 |
| 43 | 41.1 | 12.5 | 03 | 98.6 | 29.9 | 63 | 156.0 | 47.3 | 23 | 213.4 | 64.7 | 83 | 270.8 | 82.2 |
| 44 | 42.1 | 12.8 | 04 | 99.5 | 30.2 | 64 | 156.9 | 47.6 | 24 | 214.4 | 65.0 | 84 | 271.8 | 82.4 |
| 45 | 43.1 | 13.1 | 05 | 100.5 | 30.5 | 65 | 157.9 | 47.9 | 25 | 215.3 | 65.3 | 85 | 272.7 | 82.7 |
| 46 | 44.0 | 13.4 | 06 | 101.4 | 30.8 | 66 | 158.9 | 48.2 | 26 | 216.3 | 65.6 | 86 | 273.7 | 83.0 |
| 47 | 45.0 | 13.6 | 07• | 102.4 | 31.1 | 67 | 159.8 | 48.5 | 27 | 217.2 | 65.9 | 87 | 274.6 | 83.3 |
| 48 | 45.9 | 13.9 | 08 | 103.3 | 31.4 | 68 | 160.8 | 48.8 | 28 | 218.2 | 66.2 | 88 | 275.6 | 83.6 |
| 49 | 46.9 | 14.2 | 09 | 104.3 | 31.6 | 69 | 161.7 | 49.1 | 29 | 219.1 | 66.5 | 89 | 276.6 | 83.9 |
| 50 | 47.8 | 14.5 | 10 | 105.3 | 31.9 | 70 | 162.7 | 49.3 | 30 | 220.1 | 66.8 | 90 | 277.5 | 84.2 |
| 51 | 48.8 | 14.8 | 111 | 106.2 | 32.2 | 171 | 163.6 | 49.6 | 231 | 221.1 | 67.1 | 291 | 278.5 | 84.5 |
| .52 | 49.8 | 15.1 | 12 | 107.2 | 32.5 | 72 | 164.6 | 49.9 | 32 | 222.0 | 67.3 | 92 | 279.4 | 84.8 |
| 53 | 50.7 | 15.4 | 13 | 108.1 | 32.8 | 73 | 165.6 | 50.2 | 33 | 223.0 | 67.6 | 93 | 280.4 | 85.1 |
| 54 | 51.7 | 15.7 | 14 | 109.1 | 33.1 | 74 | 166.5 | 50.5 | 34 | 223.9 | 67.9 | 94 | 281.3 | 85.3 |
| 55 | 52.6 | 16.0 | 15 | 110.0 | 33.4 | 75 | 167.5 | 50.8 | 35 | 224.9 | 68.2 | 95 | 282.3 | 85.6 |
| 56 | 53.6 | 16.3 | 16 | 111.0 | 33.7 | 76 | 168.4 | 51.1 | 36 | 225.8 | 68.5 | 96 | 283.3 | 85.9 |
| 57 | 54.5 | 16.5 | 17 | 112.0 | 34.0 | 77 | 169.4 | 51.4 | 37 | 226.8 | 68.8 | 97 | 284.2 | 86.2 |
| 58 | 55.5 | 16.8 | 18 | 112.9 | 34.3 | 78 | 170.3 | 51.7 | 38 | 227.8 | 69.1 | 98 | 285.2 | 86.5 |
| 59 | 56.5 | 17.1 | 19 | 113.9 | 34.5 | 79 | 171.3 | 52.0 | 39 | 228.7 | 69.4 | 99 | 286.1 | 86.8 |
| 60 | 57.4 | 17.4 | 20 | 114.8 | 34.8 | 80 | 172.2 | 52.3 | 40 | 229.7 | 69.7 | 300 | 287.1 | 87.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

# TABLE 1.

Difference of Latitude and Departure for 1¾ Points.

| | N. by E. ¾ E. | | | N. by W. ¾ W. | | | S. by E. ¾ E. | | | S. by W. ¾ W. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.9 | 0.3 | 61 | 57.4 | 20.6 | 121 | 113.9 | 40.8 | 181 | 170.4 | 61.0 | 241 | 226.9 | 81.2 |
| 2 | 1.9 | 0.7 | 62 | 58.4 | 20.9 | 22 | 114.9 | 41.1 | 82 | 171.4 | 61.3 | 42 | 227.9 | 81.5 |
| 3 | 2.8 | 1.0 | 63 | 59.3 | 21.2 | 23 | 115.8 | 41.4 | 83 | 172.3 | 61.7 | 43 | 228.8 | 81.9 |
| 4 | 3.8 | 1.3 | 64 | 60.3 | 21.6 | 24 | 116.8 | 41.8 | 84 | 173.2 | 62.0 | 44 | 229.7 | 82.2 |
| 5 | 4.7 | 1.7 | 65 | 61.2 | 21.9 | 25 | 117.7 | 42.1 | 85 | 174.2 | 62.3 | 45 | 230.7 | 82.5 |
| 6 | 5.6 | 2.0 | 66 | 62.1 | 22.2 | 26 | 118.6 | 42.4 | 86 | 175.1 | 62.7 | 46 | 231.6 | 82.9 |
| 7 | 6.6 | 2.4 | 67 | 63.1 | 22.6 | 27 | 119.6 | 42.8 | 87 | 176.1 | 63.0 | 47 | 232.6 | 83.2 |
| 8 | 7.5 | 2.7 | 68 | 64.0 | 22.9 | 28 | 120.5 | 43.1 | 88 | 177.0 | 63.3 | 48 | 233.5 | 83.5 |
| 9 | 8.5 | 3.0 | 69 | 65.0 | 23.2 | 29 | 121.5 | 43.5 | 89 | 178.0 | 63.7 | 49 | 234.4 | 83.9 |
| 10 | 9.4 | 3.4 | 70 | 65.9 | 23.6 | 30 | 122.4 | 43.8 | 90 | 178.9 | 64.0 | 50 | 235.4 | 84.2 |
| 11 | 10.4 | 3.7 | 71 | 66.8 | 23.9 | 131 | 123.3 | 44.1 | 191 | 179.8 | 64.3 | 251 | 236.3 | 84.6 |
| 12 | 11.3 | 4.0 | 72 | 67.8 | 24.3 | 32 | 124.3 | 44.5 | 92 | 180.8 | 64.7 | 52 | 237.3 | 84.9 |
| 13 | 12.2 | 4.4 | 73 | 68.7 | 24.6 | 33 | 125.2 | 44.8 | 93 | 181.7 | 65.0 | 53 | 238.2 | 85.2 |
| 14 | 13.2 | 4.7 | 74 | 69.7 | 24.9 | 34 | 126.2 | 45.1 | 94 | 182.7 | 65.4 | 54 | 239.2 | 85.6 |
| 15 | 14.1 | 5.1 | 75 | 70.6 | 25.3 | 35 | 127.1 | 45.5 | 95 | 183.6 | 65.7 | 55 | 240.1 | 85.9 |
| 16 | 15.1 | 5.4 | 76 | 71.6 | 25.6 | 36 | 128.0 | 45.8 | 96 | 184.5 | 66.0 | 56 | 241.0 | 86.2 |
| 17 | 16.0 | 5.7 | 77 | 72.5 | 25.9 | 37 | 129.0 | 46.2 | 97 | 185.5 | 66.4 | 57 | 242.0 | 86.6 |
| 18 | 16.9 | 6.1 | 78 | 73.4 | 26.3 | 38 | 129.9 | 46.5 | 98 | 186.4 | 66.7 | 58 | 242.9 | 86.9 |
| 19 | 17.9 | 6.4 | 79 | 74.4 | 26.6 | 39 | 130.9 | 46.8 | 99 | 187.4 | 67.0 | 59 | 243.9 | 87.3 |
| 20 | 18.8 | 6.7 | 80 | 75.3 | 27.0 | 40 | 131.8 | 47.2 | 200 | 188.3 | 67.4 | 60 | 244.8 | 87.6 |
| 21 | 19.8 | 7.1 | 81 | 76.3 | 27.3 | 141 | 132.8 | 47.5 | 201 | 189.3 | 67.7 | 261 | 245.7 | 87.9 |
| 22 | 20.7 | 7.4 | 82 | 77.2 | 27.6 | 42 | 133.7 | 47.8 | 02 | 190.2 | 68.1 | 62 | 246.7 | 88.3 |
| 23 | 21.7 | 7.7 | 83 | 78.1 | 28.0 | 43 | 134.6 | 48.2 | 03 | 191.1 | 68.4 | 63 | 247.6 | 88.6 |
| 24 | 22.6 | 8.1 | 84 | 79.1 | 28.3 | 44 | 135.6 | 48.5 | 04 | 192.1 | 68.7 | 64 | 248.6 | 88.9 |
| 25 | 23.5 | 8.4 | 85 | 80.0 | 28.6 | 45 | 136.5 | 48.8 | 05 | 193.0 | 69.1 | 65 | 249.5 | 89.3 |
| 26 | 24.5 | 8.8 | 86 | 81.0 | 29.0 | 46 | 137.5 | 49.2 | 06 | 194.0 | 69.4 | ·66 | 250.5 | 89.6 |
| 27 | 25.4 | 9.1 | 87 | 81.9 | 29.3 | 47 | 138.4 | 49.5 | 07 | 194.9 | 69.7 | 67 | 251.4 | 89.9 |
| 28 | 26.4 | 9.4 | ·88 | 82.9 | 29.6 | 48 | 139.3 | 49.9 | 08 | 195.8 | 70.1 | 68 | 252.3 | 90.3 |
| 29 | 27.3 | 9.8 | 89 | 83.8 | 30.0 | 49 | 140.3 | 50.2 | 09 | 196.8 | 70.4 | 69 | 253.3 | 90.6 |
| 30 | 28.2 | 10.1 | 90 | 84.7 | 30.3 | 50 | 141.2 | 50.5 | 10 | 197.7 | 70.7 | 70 | 254.2 | 91.0 |
| 31 | 29.2 | 10.4 | 91 | 85.7 | 30.7 | 151 | 142.2 | 50.9 | 211 | 198.7 | 71.1 | 271 | 255.2 | 91.3 |
| 32 | 30.1 | 10.8 | 92 | 86.6 | 31.0 | 52 | 143.1 | 51.2 | 12 | 199.6 | 71.4 | 72 | 256.1 | 91.6 |
| 33 | 31.1 | 11.1 | 93 | 87.6 | 31.3 | 53 | 144.1 | 51.5 | 13 | 200.5 | 71.8 | 73 | 257.0 | 92.0 |
| 34 | 32.0 | 11.5 | 94 | 88.5 | 31.7 | 54 | 145.0 | 51.9 | 14 | 201.5 | 72.1 | 74 | 258.0 | 92.3 |
| 35 | 33.0 | 11.8 | 95 | 89.4 | 32.0 | 55 | 145.9 | 52.2 | 15 | 202.4 | 72.4 | 75 | 258.9 | 92.6 |
| 36 | 33.9 | 12.1 | 96 | 90.4 | 32.3 | 56 | 146.9 | 52.6 | 16 | 203.4 | 72.8 | 76 | 259.9 | 93.0 |
| 37 | 34.8 | 12.5 | 97 | 91.3 | 32.7 | 57 | 147.8 | 52.9 | 17 | 204.3 | 73.1 | 77 | 260.8 | 93.3 |
| 38 | 35.8 | 12.8 | 98 | 92.3 | 33.0 | 58 | 148.8 | 53.2 | 18 | 205.3 | 73.4 | 78 | 261.7 | 93.7 |
| 39 | 36.7 | 13.1 | 99 | 93.2 | 33.4 | 59 | 149.7 | 53.6 | 19 | 206.2 | 73.8 | 79 | 262.7 | 94.0 |
| 40 | 37.7 | 13.5 | 100 | 94.2 | 33.7 | 60 | 150.6 | 53.9 | 20 | 207.1 | 74.1 | 80 | 263.6 | 94.3 |
| 41 | 38.6 | 13.8 | 101 | 95.1 | 34.0 | 161 | 151.6 | 54.2 | 221 | 208.1 | 74.5 | 281 | 264.6 | 94.7 |
| 42 | 39.5 | 14.1 | 02 | 96.0 | 34.4 | 62 | 152.5 | 54.6 | 22 | 209.0 | 74.8 | 82 | 265.5 | 95.0 |
| 43 | 40.5 | 14.5 | 03 | 97.0 | 34.7 | 63 | 153.5 | 54.9 | 23 | 210.0 | 75.1 | 83 | 266.5 | 95.3 |
| 44 | 41.4 | 14.8 | 04 | 97.9 | 35.0 | 64 | 154.4 | 55.2 | 24 | 210.9 | 75.5 | 84 | 267.4 | 95.7 |
| 45 | 42.4 | 15.2 | 05 | 98.9 | 35.4 | 65 | 155.4 | 55.6 | 25 | 211.8 | 75.8 | 85 | 268.3 | 96.0 |
| 46 | 43.3 | 15.5 | 06 | 99.8 | 35.7 | 66 | 156.3 | 55.9 | 26 | 212.8 | 76.1 | 86 | 269.3 | 96.4 |
| 47 | 44.3 | 15.8 | 07 | 100.7 | 36.0 | 67 | 157.2 | 56.3 | 27 | 213.7 | 76.5 | 87 | 270.2 | 96.7 |
| 48 | 45.2 | 16.2 | 08 | 101.7 | 36.4 | 68 | 158.2 | 56.6 | 28 | 214.7 | 76.8 | 88 | 271.2 | 97.0 |
| 49 | 46.1 | 16.5 | 09 | 102.6 | 36.7 | 69 | 159.1 | 56.9 | 29 | 215.6 | 77.1 | 89 | 272.1 | 97.4 |
| 50 | 47.1 | 16.8 | 10 | 103.6 | 37.1 | 70 | 160.1 | 57.3 | 30 | 216.6 | 77.5 | 90 | 273.0 | 97.7 |
| 51 | 48.0 | 17.2 | 111 | 104.5 | 37.4 | 171 | 161.0 | 57.6 | 231 | 217.5 | 77.8 | 291 | 274.0 | 98.0 |
| 52 | 49.0 | 17.5 | 12 | 105.5 | 37.7 | 72 | 161.9 | 57.9 | 32 | 218.4 | 78.2 | 92 | 274.9 | 98.4 |
| 53 | 49.9 | 17.9 | 13 | 106.4 | 38.1 | 73 | 162.9 | 58.3 | 33 | 219.4 | 78.5 | 93 | 275.9 | 98.7 |
| 54 | 50.8 | 18.2 | 14 | 107.3 | 38.4 | 74 | 163.8 | 58.6 | 34 | 220.3 | 78.8 | 94 | 276.8 | 99.0 |
| 55 | 51.8 | 18.5 | 15 | 108.3 | 38.7 | 75 | 164.8 | 59.0 | 35 | 221.3 | 79.2 | 95 | 277.8 | 99.4 |
| 56 | 52.7 | 18.9 | 16 | 109.2 | 39.1 | 76 | 165.7 | 59.3 | 36 | 222.2 | 79.5 | 96 | 278.7 | 99.7 |
| 57 | 53.7 | 19.2 | 17 | 110.2 | 39.4 | 77 | 166.7 | 59.6 | 37 | 223.1 | 79.8 | 97 | 279.6 | 100.1 |
| 58 | 54.6 | 19.5 | 18 | 111.1 | 39.8 | 78 | 167.6 | 60.0 | 38 | 224.1 | 80.2 | 98 | 280.6 | 100.4 |
| 59 | 55.6 | 19.9 | 19 | 112.0 | 40.1 | 79 | 168.5 | 60.3 | 39 | 225.0 | 80.5 | 99 | 281.5 | 100.7 |
| 60 | 56.5 | 20.2 | 20 | 113.0 | 40.4 | 80 | 169.5 | 60.6 | 40 | 226.0 | 80.9 | 300 | 282.5 | 101.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| | ENE. ¼ E. | | | ESE. ¼ E. | | | WNW. ¼ W. | | | WSW. ¼ W. | | [For 6¼ Points. |

TABLE 1. [Page 359

Difference of Latitude and Departure for 2 Points.

| | NNE. | | | NNW. | | | SSE. | | | SSW. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.9 | 0.4 | 61 | 56.4 | 23.3 | 121 | 111.8 | 46.3 | 181 | 167.2 | 69.3 | 241 | 222.7 | 92.2 |
| 2 | 1.8 | 0.8 | 62 | 57.3 | 23.7 | 22 | 112.7 | 46.7 | 82 | 168.1 | 69.6 | 42 | 223.6 | 92.6 |
| 3 | 2.8 | 1.1 | 63 | 58.2 | 24.1 | 23 | 113.6 | 47.1 | 83 | 169.1 | 70.0 | 43 | 224.5 | 93.0 |
| 4 | 3.7 | 1.5 | 64 | 59.1 | 24.5 | 24 | 114.6 | 47.5 | 84 | 170.0 | 70.4 | 44 | 225.4 | 93.4 |
| 5 | 4.6 | 1.9 | 65 | 60.1 | 24.9 | 25 | 115.5 | 47.8 | 85 | 170.9 | 70.8 | 45 | 226.4 | 93.8 |
| 6 | 5.5 | 2.3 | 66 | 61.0 | 25.3 | 26 | 116.4 | 48.2 | 86 | 171.8 | 71.2 | 46 | 227.3 | 94.1 |
| 7 | 6.5 | 2.7 | 67 | 61.9 | 25.6 | 27 | 117.3 | 48.6 | 87 | 172.8 | 71.6 | 47 | 228.2 | 94.5 |
| 8 | 7.4 | 3.1 | 68 | 62.8 | 26.0 | 28 | 118.3 | 49.0 | 88 | 173.7 | 71.9 | 48 | 229.1 | 94.9 |
| 9 | 8.3 | 3.4 | 69 | 63.7 | 26.4 | 29 | 119.2 | 49.4 | 89 | 174.6 | 72.3 | 49 | 230.0 | 95.3 |
| 10 | 9.2 | 3.8 | 70 | 64.7 | 26.8 | 30 | 120.1 | 49.7 | 90 | 175.5 | 72.7 | 50 | 231.0 | 95.7 |
| 11 | 10.2 | 4.2 | 71 | 65.6 | 27.2 | 131 | 121.0 | 50.1 | 191 | 176.5 | 73.1 | 251 | 231.9 | 96.1 |
| 12 | 11.1 | 4.6 | 72 | 66.5 | 27.6 | 32 | 122.0 | 50.5 | 92 | 177.4 | 73.5 | 52 | 232.8 | 96.4 |
| 13 | 12.0 | 5.0 | 73 | 67.4 | 27.9 | 33 | 122.9 | 50.9 | 93 | 178.3 | 73.9 | 53 | 233.7 | 96.8 |
| 14 | 12.9 | 5.4 | 74 | 68.4 | 28.3 | 34 | 123.8 | 51.3 | 94 | 179.2 | 74.2 | 54 | 234.7 | 97.2 |
| 15 | 13.9 | 5.7 | 75 | 69.3 | 28.7 | 35 | 124.7 | 51.7 | 95 | 180.2 | 74.6 | 55 | 235.6 | 97.6 |
| 16 | 14.8 | 6.1 | 76 | 70.2 | 29.1 | 36 | 125.6 | 52.0 | 96 | 181.1 | 75.0 | 56 | 236.5 | 98.0 |
| 17 | 15.7 | 6.5 | 77 | 71.1 | 29.5 | 37 | 126.6 | 52.4 | 97 | 182.0 | 75.4 | 57 | 237.4 | 98.3 |
| 18 | 16.6 | 6.9 | 78 | 72.1 | 29.8 | 38 | 127.5 | 52.8 | 98 | 182.9 | 75.8 | 58 | 238.4 | 98.7 |
| 19 | 17.6 | 7.3 | 79 | 73.0 | 30.2 | 39 | 128.4 | 53.2 | 99 | 183.9 | 76.2 | 59 | 239.3 | 99.1 |
| 20 | 18.5 | 7.7 | 80 | 73.9 | 30.6 | 40 | 129.3 | 53.6 | 200 | 184.8 | 76.5 | 60 | 240.2 | 99.5 |
| 21 | 19.4 | 8.0 | 81 | 74.8 | 31.0 | 141 | 130.3 | 54.0 | 201 | 185.7 | 76.9 | 261 | 241.1 | 99.9 |
| 22 | 20.3 | 8.4 | 82 | 75.8 | 31.4 | 42 | 131.2 | 54.3 | 02 | 186.6 | 77.3 | 62 | 242.1 | 100.3 |
| 23 | 21.2 | 8.8 | 83 | 76.7 | 31.8 | 43 | 132.1 | 54.7 | 03 | 187.5 | 77.7 | 63 | 243.0 | 100.6 |
| 24 | 22.2 | 9.2 | 84 | 77.6 | 32.1 | 44 | 133.0 | 55.1 | 04 | 188.5 | 78.1 | 64 | 243.9 | 101.0 |
| 25 | 23.1 | 9.6 | 85 | 78.5 | 32.5 | 45 | 134.0 | 55.5 | 05 | 189.4 | 78.5 | 65 | 244.8 | 101.4 |
| 26 | 24.0 | 9.9 | 86 | 79.5 | 32.9 | 46 | 134.9 | 55.9 | 06 | 190.3 | 78.8 | 66 | 245.8 | 101.8 |
| 27 | 24.9 | 10.3 | 87 | 80.4 | 33.3 | 47 | 135.8 | 56.3 | 07 | 191.2 | 79.2 | 67 | 246.7 | 102.2 |
| 28 | 25.9 | 10.7 | 88 | 81.3 | 33.7 | 48 | 136.7 | 56.6 | 08 | 192.2 | 79.6 | 68 | 247.6 | 102.6 |
| 29 | 26.8 | 11.1 | 89 | 82.2 | 34.1 | 49 | 137.7 | 57.0 | 09 | 193.1 | 80.0 | 69 | 248.5 | 102.9 |
| 30 | 27.7 | 11.5 | 90 | 83.1 | 34.4 | 50 | 138.6 | 57.4 | 10 | 194.0 | 80.4 | 70 | 249.4 | 103.3 |
| 31 | 28.6 | 11.9 | 91 | 84.1 | 34.8 | 151 | 139.5 | 57.8 | 211 | 194.9 | 80.7 | 271 | 250.4 | 103.7 |
| 32 | 29.6 | 12.2 | 92 | 85.0 | 35.2 | 52 | 140.4 | 58.2 | 12 | 195.9 | 81.1 | 72 | 251.3 | 104.1 |
| 33 | 30.5 | 12.6 | 93 | 85.9 | 35.6 | 53 | 141.4 | 58.6 | 13 | 196.8 | 81.5 | 73 | 252.2 | 104.5 |
| 34 | 31.4 | 13.0 | 94 | 86.8 | 36.0 | 54 | 142.3 | 58.9 | 14 | 197.7 | 81.9 | 74 | 253.1 | 104.9 |
| 35 | 32.3 | 13.4 | 95 | 87.8 | 36.4 | 55 | 143.2 | 59.3 | 15 | 198.6 | 82.3 | 75 | 254.1 | 105.2 |
| 36 | 33.3 | 13.8 | 96 | 88.7 | 36.7 | 56 | 144.1 | 59.7 | 16 | 199.6 | 82.7 | 76 | 255.0 | 105.6 |
| 37 | 34.2 | 14.2 | 97 | 89.6 | 37.1 | 57 | 145.0 | 60.1 | 17 | 200.5 | 83.0 | 77 | 255.9 | 106.0 |
| 38 | 35.1 | 14.5 | 98 | 90.5 | 37.5 | 58 | 146.0 | 60.5 | 18 | 201.4 | 83.4 | 78 | 256.8 | 106.4 |
| 39 | 36.0 | 14.9 | 99 | 91.5 | 37.9 | 59 | 146.9 | 60.8 | 19 | 202.3 | 83.8 | 79 | 257.8 | 106.8 |
| 40 | 37.0 | 15.3 | 100 | 92.4 | 38.3 | 60 | 147.8 | 61.2 | 20 | 203.3 | 84.2 | 80 | 258.7 | 107.2 |
| 41 | 37.9 | 15.7 | 101 | 93.3 | 38.7 | 161 | 148.7 | 61.6 | 221 | 204.2 | 84.6 | 281 | 259.6 | 107.5 |
| 42 | 38.8 | 16.1 | 02 | 94.2 | 39.0 | 62 | 149.7 | 62.0 | 22 | 205.1 | 85.0 | 82 | 260.5 | 107.9 |
| 43 | 39.7 | 16.5 | 03 | 95.2 | 39.4 | 63 | 150.6 | 62.4 | 23 | 206.0 | 85.3 | 83 | 261.5 | 108.3 |
| 44 | 40.7 | 16.8 | 04 | 96.1 | 39.8 | 64 | 151.5 | 62.8 | 24 | 206.9 | 85.7 | 84 | 262.4 | 108.7 |
| 45 | 41.6 | 17.2 | 05 | 97.0 | 40.2 | 65 | 152.4 | 63.1 | 25 | 207.9 | 86.1 | 85 | 263.3 | 109.1 |
| 46 | 42.5 | 17.6 | 06 | 97.9 | 40.6 | 66 | 153.4 | 63.5 | 26 | 208.8 | 86.5 | 86 | 264.2 | 109.4 |
| 47 | 43.4 | 18.0 | 07 | 98.9 | 40.9 | 67 | 154.3 | 63.9 | 27 | 209.7 | 86.9 | 87 | 265.2 | 109.8 |
| 48 | 44.3 | 18.4 | 08 | 99.8 | 41.3 | 68 | 155.2 | 64.3 | 28 | 210.6 | 87.3 | 88 | 266.1 | 110.2 |
| 49 | 45.3 | 18.8 | 09 | 100.7 | 41.7 | 69 | 156.1 | 64.7 | 29 | 211.6 | 87.6 | 89 | 267.0 | 110.6 |
| 50 | 46.2 | 19.1 | 10 | 101.6 | 42.1 | 70 | 157.1 | 65.1 | 30 | 212.5 | 88.0 | 90 | 267.9 | 111.0 |
| 51 | 47.1 | 19.5 | 111 | 102.6 | 42.5 | 171 | 158.0 | 65.4 | 231 | 213.4 | 88.4 | 291 | 268.8 | 111.4 |
| 52 | 48.0 | 19.9 | 12 | 103.5 | 42.9 | 72 | 158.9 | 65.8 | 32 | 214.3 | 88.8 | 92 | 269.8 | 111.7 |
| 53 | 49.0 | 20.3 | 13 | 104.4 | 43.2 | 73 | 159.8 | 66.2 | 33 | 215.3 | 89.2 | 93 | 270.7 | 112.1 |
| 54 | 49.9 | 20.7 | 14 | 105.3 | 43.6 | 74 | 160.8 | 66.6 | 34 | 216.2 | 89.5 | 94 | 271.6 | 112.5 |
| 55 | 50.8 | 21.0 | 15 | 106.2 | 44.0 | 75 | 161.7 | 67.0 | 35 | 217.1 | 89.9 | 95 | 272.5 | 112.9 |
| 56 | 51.7 | 21.4 | 16 | 107.2 | 44.4 | 76 | 162.6 | 67.4 | 36 | 218.0 | 90.3 | 96 | 273.5 | 113.3 |
| 57 | 52.7 | 21.8 | 17 | 108.1 | 44.8 | 77 | 163.5 | 67.7 | 37 | 219.0 | 90.7 | 97 | 274.4 | 113.7 |
| 58 | 53.6 | 22.2 | 18 | 109.0 | 45.2 | 78 | 164.5 | 68.1 | 38 | 219.9 | 91.1 | 98 | 275.3 | 114.0 |
| 59 | 54.5 | 22.6 | 19 | 109.9 | 45.5 | 79 | 165.4 | 68.5 | 39 | 220.8 | 91.5 | 99 | 276.2 | 114.4 |
| 60 | 55.4 | 23.0 | 20 | 110.9 | 45.9 | 80 | 166.3 | 68.9 | 40 | 221.7 | 91.8 | 300 | 277.2 | 114.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat, | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| ENE. | | ESE. | | WNW | | WSW | | [For 6 Points. |
|---|---|---|---|---|---|---|---|---|

# TABLE 1.

Difference of Latitude and Departure for 2¼ Points.

| NNE. ¼ E. | | | NNW. ¼ W. | | | SSE. ¼ E. | | | SSW. ¼ W. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.9 | 0.4 | 61 | 55.1 | 26.1 | 121 | 109.4 | 51.7 | 181 | 163.6 | 77.4 | 241 | 217.9 | 103.0 |
| 2 | 1.8 | 0.9 | 62 | 56.0 | 26.5 | 22 | 110.3 | 52.2 | 82 | 164.5 | 77.8 | 42 | 218.8 | 103.5 |
| 3 | 2.7 | 1.3 | 63 | 57.0 | 26.9 | 23 | 111.2 | 52.6 | 83 | 165.4 | 78.2 | 43 | 219.7 | 103.9 |
| 4 | 3.6 | 1.7 | 64 | 57.9 | 27.4 | 24 | 112.1 | 53.0 | 84 | 166.3 | 78.7 | 44 | 220.6 | 104.3 |
| 5 | 4.5 | 2.1 | 65 | 58.8 | 27.8 | 25 | 113.0 | 53.4 | 85 | 167.2 | 79.1 | 45 | 221.5 | 104.8 |
| 6 | 5.4 | 2.6 | 66 | 59.7 | 28.2 | 26 | 113.9 | 53.9 | 86 | 168.1 | 79.5 | 46 | 222.4 | 105.2 |
| 7 | 6.3 | 3.0 | 67 | 60.6 | 28.6 | 27 | 114.8 | 54.3 | 87 | 169.0 | 80.0 | 47 | 223.3 | 105.6 |
| 8 | 7.2 | 3.4 | 68 | 61.5 | 29.1 | 28 | 115.7 | 54.7 | 88 | 169.9 | 80.4 | 48 | 224.2 | 106.0 |
| 9 | 8.1 | 3.8 | 69 | 62.4 | 29.5 | 29 | 116.6 | 55.2 | 89 | 170.9 | 80.8 | 49 | 225.1 | 106.5 |
| 10 | 9.0 | 4.3 | 70 | 63.3 | 29.9 | 30 | 117.5 | 55.6 | 90 | 171.8 | 81.2 | 50 | 226.0 | 106.9 |
| 11 | 9.9 | 4.7 | 71 | 64.2 | 30.4 | 131 | 118.4 | 56.0 | 191 | 172.7 | 81.7 | 251 | 226.9 | 107.3 |
| 12 | 10.8 | 5.1 | 72 | 65.1 | 30.8 | 32 | 119.3 | 56.4 | 92 | 173.6 | 82.1 | 52 | 227.8 | 107.7 |
| 13 | 11.8 | 5.6 | 73 | 66.0 | 31.2 | 33 | 120.2 | 56.9 | 93 | 174.5 | 82.5 | 53 | 228.7 | 108.2 |
| 14 | 12.7 | 6.0 | 74 | 66.9 | 31.6 | 34 | 121.1 | 57.3 | 94 | 175.4 | 82.9 | 54 | 229.6 | 108.6 |
| 15 | 13.6 | 6.4 | 75 | 67.8 | 32.1 | 35 | 122.0 | 57.7 | 95 | 176.3 | 83.4 | 55 | 230.5 | 109.0 |
| 16 | 14.5 | 6.8 | 76 | 68.7 | 32.5 | 36 | 122.9 | 58.1 | 96 | 177.2 | 83.8 | 56 | 231.4 | 109.5 |
| 17 | 15.4 | 7.3 | 77 | 69.6 | 32.9 | 37 | 123.8 | 58.6 | 97 | 178.1 | 84.2 | 57 | 232.3 | 109.9 |
| 18 | 16.3 | 7.7 | 78 | 70.5 | 33.3 | 38 | 124.8 | 59.0 | 98 | 179.0 | 84.7 | 58 | 233.2 | 110.3 |
| 19 | 17.2 | 8.1 | 79 | 71.4 | 33.8 | 39 | 125.7 | 59.4 | 99 | 179.9 | 85.1 | 59 | 234.1 | 110.7 |
| 20 | 18.1 | 8.6 | 80 | 72.3 | 34.2 | 40 | 126.6 | 59.9 | 200 | 180.8 | 85.5 | 60 | 235.0 | 111.2 |
| 21 | 19.0 | 9.0 | 81 | 73.2 | 34.6 | 141 | 127.5 | 60.3 | 201 | 181.7 | 85.9 | 261 | 235.9 | 111.6 |
| 22 | 19.9 | 9.4 | 82 | 74.1 | 35.1 | 42 | 128.4 | 60.7 | 02 | 182.6 | 86.4 | 62 | 236.8 | 112.0 |
| 23 | 20.8 | 9.8 | 83 | 75.0 | 35.5 | 43 | 129.3 | 61.1 | 03 | 183.5 | 86.8 | 63 | 237.7 | 112.4 |
| 24 | 21.7 | 10.3 | 84 | 75.9 | 35.9 | 44 | 130.2 | 61.6 | 04 | 184.4 | 87.2 | 64 | 238.7 | 112.9 |
| 25 | 22.6 | 10.7 | 85 | 76.8 | 36.3 | 45 | 131.1 | 62.0 | 05 | 185.3 | 87.6 | 65 | 239.6 | 113.3 |
| 26 | 23.5 | 11.1 | 86 | 77.7 | 36.8 | 46 | 132.0 | 62.4 | 06 | 186.2 | 88.1 | 66 | 240.5 | 113.7 |
| 27 | 24.4 | 11.5 | 87 | 78.6 | 37.2 | 47 | 132.9 | 62.9 | 07 | 187.1 | 88.5 | 67 | 241.4 | 114.2 |
| 28 | 25.3 | 12.0 | 88 | 79.6 | 37.6 | 48 | 133.8 | 63.3 | 08 | 188.0 | 88.9 | 68 | 242.3 | 114.6 |
| 29 | 26.2 | 12.4 | 89 | 80.5 | 38.1 | 49 | 134.7 | 63.7 | 09 | 188.9 | 89.4 | 69 | 243.2 | 115.0 |
| 30 | 27.1 | 12.8 | 90 | 81.4 | 38.5 | 50 | 135.6 | 64.1 | 10 | 189.8 | 89.8 | 70 | 244.1 | 115.4 |
| 31 | 28.0 | 13.3 | 91 | 82.3 | 38.9 | 151 | 136.5 | 64.6 | 211 | 190.7 | 90.2 | 271 | 245.0 | 115.9 |
| 32 | 28.9 | 13.7 | 92 | 83.2 | 39.3 | 52 | 137.4 | 65.0 | 12 | 191.6 | 90.6 | 72 | 245.9 | 116.3 |
| 33 | 29.8 | 14.1 | 93 | 84.1 | 39.8 | 53 | 138.3 | 65.4 | 13 | 192.5 | 91.1 | 73 | 246.8 | 116.7 |
| 34 | 30.7 | 14.5 | 94 | 85.0 | 40.2 | 54 | 139.2 | 65.8 | 14 | 193.5 | 91.5 | 74 | 247.7 | 117.2 |
| 35 | 31.6 | 15.0 | 95 | 85.9 | 40.6 | 55 | 140.1 | 66.3 | 15 | 194.4 | 91.9 | 75 | 248.6 | 117.6 |
| 36 | 32.5 | 15.4 | 96 | 86.8 | 41.0 | 56 | 141.0 | 66.7 | 16 | 195.3 | 92.4 | 76 | 249.5 | 118.0 |
| 37 | 33.4 | 15.8 | 97 | 87.7 | 41.5 | 57 | 141.9 | 67.1 | 17 | 196.2 | 92.8 | 77 | 250.4 | 118.4 |
| 38 | 34.4 | 16.2 | 98 | 88.6 | 41.9 | 58 | 142.8 | 67.6 | 18 | 197.1 | 93.2 | 78 | 251.3 | 118.9 |
| 39 | 35.3 | 16.7 | 99 | 89.5 | 42.3 | 59 | 143.7 | 68.0 | 19 | 198.0 | 93.6 | 79 | 252.2 | 119.3 |
| 40 | 36.2 | 17.1 | 100 | 90.4 | 42.8 | 60 | 144.6 | 68.4 | 20 | 198.9 | 94.1 | 80 | 253.1 | 119.7 |
| 41 | 37.1 | 17.5 | 101 | 91.3 | 43.2 | 161 | 145.5 | 68.8 | 221 | 199.8 | 94.5 | 281 | 254.0 | 120.1 |
| 42 | 38.0 | 18.0 | 02 | 92.2 | 43.6 | 62 | 146.4 | 69.3 | 22 | 200.7 | 94.9 | 82 | 254.9 | 120.6 |
| 43 | 38.9 | 18.4 | 03 | 93.1 | 44.0 | 63 | 147.4 | 69.7 | 23 | 201.6 | 95.3 | 83 | 255.8 | 121.0 |
| 44 | 39.8 | 18.8 | 04 | 94.0 | 44.5 | 64 | 148.3 | 70.1 | 24 | 202.5 | 95.8 | 84 | 256.7 | 121.4 |
| 45 | 40.7 | 19.2 | 05 | 94.9 | 44.9 | 65 | 149.2 | 70.5 | 25 | 203.4 | 96.2 | 85 | 257.6 | 121.9 |
| 46 | 41.6 | 19.7 | 06 | 95.8 | 45.3 | 66 | 150.1 | 71.0 | 26 | 204.3 | 96.6 | 86 | 258.5 | 122.3 |
| 47 | 42.5 | 20.1 | 07 | 96.7 | 45.7 | 67 | 151.0 | 71.4 | 27 | 205.2 | 97.1 | 87 | 259.4 | 122.7 |
| 48 | 43.4 | 20.5 | 08 | 97.6 | 46.2 | 68 | 151.9 | 71.8 | 28 | 206.1 | 97.5 | 88 | 260.3 | 123.1 |
| 49 | 44.3 | 21.0 | 09 | 98.5 | 46.6 | 69 | 152.8 | 72.3 | 29 | 207.0 | 97.9 | 89 | 261.3 | 123.6 |
| 50 | 45.2 | 21.4 | 10 | 99.4 | 47.0 | 70 | 153.7 | 72.7 | 30 | 207.9 | 98.3 | 90 | 262.2 | 124.0 |
| 51 | 46.1 | 21.8 | 111 | 100.3 | 47.5 | 171 | 154.6 | 73.1 | 231 | 208.8 | 98.8 | 291 | 263.1 | 124.4 |
| 52 | 47.0 | 22.2 | 12 | 101.2 | 47.9 | 72 | 155.5 | 73.5 | 32 | 209.7 | 99.2 | 92 | 264.0 | 124.8 |
| 53 | 47.9 | 22.7 | 13 | 102.2 | 48.3 | 73 | 156.4 | 74.0 | 33 | 210.6 | 99.6 | 93 | 264.9 | 125.3 |
| 54 | 48.8 | 23.1 | 14 | 103.1 | 48.7 | 74 | 157.3 | 74.4 | 34 | 211.5 | 100.0 | 94 | 265.8 | 125.7 |
| 55 | 49.7 | 23.5 | 15 | 104.0 | 49.2 | 75 | 158.2 | 74.8 | 35 | 212.4 | 100.5 | 95 | 266.7 | 126.1 |
| 56 | 50.6 | 23.9 | 16 | 104.9 | 49.6 | 76 | 159.1 | 75.2 | 36 | 213.3 | 100.9 | 96 | 267.6 | 126.6 |
| 57 | 51.5 | 24.4 | 17 | 105.8 | 50.0 | 77 | 160.0 | 75.7 | 37 | 214.2 | 101.3 | 97 | 268.5 | 127.0 |
| 58 | 52.4 | 24.8 | 18 | 106.7 | 50.5 | 78 | 160.9 | 76.1 | 38 | 215.1 | 101.8 | 98 | 269.4 | 127.4 |
| 59 | 53.3 | 25.2 | 19 | 107.6 | 50.9 | 79 | 161.8 | 76.5 | 39 | 216.1 | 102.2 | 99 | 270.3 | 127.8 |
| 60 | 54.2 | 25.7 | 20 | 108.5 | 51.3 | 80 | 162.7 | 77.0 | 40 | 217.0 | 102.6 | 300 | 271.2 | 128.3 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

NE. by E. ¾ E.　　SE. by E. ¼ E.　　NW. by W. ¾ W.　　SW. by W. ¾ W.　　[For 5¾ Points.

TABLE 1. [Page 361

Difference of Latitude and Departure for 2½ Points.

| NNE. ½ E. | | | NNW. ½ W. | | | SSE. ½ E. | | | SSW. ½ W. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.9 | 0.5 | 61 | 53.8 | 28.8 | 121 | 106.7 | 57.0 | 181 | 159.6 | 85.3 | 241 | 212.5 | 113.6 |
| 2 | 1.8 | 0.9 | 62 | 54.7 | 29.2 | 22 | 107.6 | 57.5 | 82 | 160.5 | 85.8 | 42 | 213.4 | 114.1 |
| 3 | 2.6 | 1.4 | 63 | 55.6 | 29.7 | 23 | 108.5 | 58.0 | 83 | 161.4 | 86.3 | 43 | 214.3 | 114.5 |
| 4 | 3.5 | 1.9 | 64 | 56.4 | 30.2 | 24 | 109.4 | 58.5 | 84 | 162.3 | 86.7 | 44 | 215.2 | 115.0 |
| 5 | 4.4 | 2.4 | 65 | 57.3 | 30.6 | 25 | 110.2 | 58.9 | 85 | 163.2 | 87.2 | 45 | 216.1 | 115.5 |
| 6 | 5.3 | 2.8 | 66 | 58.2 | 31.1 | 26 | 111.1 | 59.4 | 86 | 164.0 | 87.7 | 46 | 217.0 | 116.0 |
| 7 | 6.2 | 3.3 | 67 | 59.1 | 31.6 | 27 | 112.0 | 59.9 | 87 | 164.9 | 88.2 | 47 | 217.8 | 116.4 |
| 8 | 7.1 | 3.8 | 68 | 60.0 | 32.1 | 28 | 112.9 | 60.3 | 88 | 165.8 | 88.6 | 48 | 218.7 | 116.9 |
| 9 | 7.9 | 4.2 | 69 | 60.9 | 32.5 | 29 | 113.8 | 60.8 | 89 | 166.7 | 89.1 | 49 | 219.6 | 117.4 |
| 10 | 8.8 | 4.7 | 70 | 61.7 | 33.0 | 30 | 114.6 | 61.3 | 90 | 167.6 | 89.6 | 50 | 220.5 | 117.8 |
| 11 | 9.7 | 5.2 | 71 | 62.6 | 33.5 | 131 | 115.5 | 61.8 | 191 | 168.4 | 90.0 | 251 | 221.4 | 118.3 |
| 12 | 10.6 | 5.7 | 72 | 63.5 | 33.9 | 32 | 116.4 | 62.2 | 92 | 169.3 | 90.5 | 52 | 222.2 | 118.8 |
| 13 | 11.5 | 6.1 | 73 | 64.4 | 34.4 | 33 | 117.3 | 62.7 | 93 | 170.2 | 91.0 | 53 | 223.1 | 119.3 |
| 14 | 12.3 | 6.6 | 74 | 65.3 | 34.9 | 34 | 118.2 | 63.2 | 94 | 171.1 | 91.5 | 54 | 224.0 | 119.7 |
| 15 | 13.2 | 7.1 | 75 | 66.1 | 35.4 | 35 | 119.1 | 63.6 | 95 | 172.0 | 91.9 | 55 | 224.9 | 120.2 |
| 16 | 14.1 | 7.5 | 76 | 67.0 | 35.8 | 36 | 119.9 | 64.1 | 96 | 172.9 | 92.4 | 56 | 225.8 | 120.7 |
| 17. | 15.0 | 8.0 | 77 | 67.9 | 36.3 | 37 | 120.8 | 64.6 | 97 | 173.7 | 92.9 | 57 | 226.7 | 121.1 |
| 18 | 15.9 | 8.5 | 78 | 68.8 | 36.8 | 38 | 121.7 | 65.1 | 98 | 174.6 | 93.3 | 58 | 227.5 | 121.6 |
| 19 | 16.8 | 9.0 | 79 | 69.7 | 37.2 | 39 | 122.6 | 65.5 | 99 | 175.5 | 93.8 | 59 | 228.4 | 122.1 |
| 20 | 17.6 | 9.4 | 80 | 70.6 | 37.7 | 40 | 123.5 | 66.0 | 200 | 176.4 | 94.3 | 60 | 229.3 | 122.6 |
| 21 | 18.5 | 9.9 | 81 | 71.4 | 38.2 | 141 | 124.4 | 66.5 | 201 | 177.3 | 94.8 | 261 | 330.2 | 123.0 |
| 22 | 19.4 | 10.4 | 82 | 72.3 | 38.7 | 42 | 125.2 | 66.9 | 02 | 178.1 | 95.2 | 62 | 231.1 | 123.5 |
| 23 | 20.3 | 10.8 | 83 | 73.2 | 39.1 | 43 | 126.1 | 67.4 | 03 | 179.0 | 95.7 | 63 | 231.9 | 124.0 |
| 24 | 21.2 | 11.3 | 84 | 74.1 | 39.6 | 44 | 127.0 | 67.9 | 04 | 179.9 | 96.2 | 64 | 232.8 | 124.4 |
| 25 | 22.0 | 11.8 | 85 | 75.0 | 40.1 | 45 | 127.9 | 68.4 | 05 | 180.8 | 96.6 | 65 | 233.7 | 124.9 |
| 26 | 22.9 | 12.3 | 86 | 75.8 | 40.5 | 46 | 128.8 | 68.8 | 06 | 181.7 | 97.1 | 66 | 234.6 | 125.4 |
| 27 | 23.8 | 12.7 | 87 | 76.7 | 41.0 | 47 | 129.6 | 69.3 | 07 | 182.6 | 97.6 | 67 | 235.5 | 125.9 |
| 28 | 24.7 | 13.2 | 88 | 77.6 | 41.5 | 48 | 130.5 | 69.8 | 08 | 183.4 | 98.1 | 68 | 236.4 | 126.3 |
| 29 | 25.6 | 13.7 | 89 | 78.5 | 42.0 | 49 | 131.4 | 70.2 | 09 | 184.3 | 98.5 | 69 | 237.2 | 126.8 |
| 30 | 26.5 | 14.1 | 90 | 79.4 | 42.4 | 50 | 132.3 | 70.7 | 10 | 185.2 | 99.0 | 70 | 238.1 | 127.3 |
| 31 | 27.3 | 14.6 | 91 | 80.3 | 42.9 | 151 | 133.2 | 71.2 | 211 | 186.1 | 99.5 | 271 | 239.0 | 127.7 |
| 32 | 28.2 | 15.1 | 92 | 81.1 | 43.4 | 52 | 134.1 | 71.7 | 12 | 187.0 | 99.9 | 72 | 239.9 | 128.2 |
| 33 | 29.1 | 15.6 | 93 | 82.0 | 43.8 | 53 | 134.9 | 72.1 | 13 | 187.8 | 100.4 | 73 | 240.8 | 128.7 |
| 34 | 30.0 | 16.0 | 94 | 82.9 | 44.3 | 54 | 135.8 | 72.6 | 14 | 188.7 | 100.9 | 74 | 241.6 | 129.2 |
| 35 | 30.9 | 16.5 | 95 | 83.8 | 44.8 | 55 | 136.7 | 73.1 | 15 | 189.6 | 101.4 | 75 | 242.5 | 129.6 |
| 36 | 31.7 | 17.0 | 96 | 84.7 | 45.3 | 56 | 137.6 | 73.5 | 16 | 190.5 | 101.8 | 76 | 243.4 | 130.1 |
| 37 | 32.6 | 17.4 | 97 | 85.5 | 45.7 | 57 | 138.5 | 74.0 | 17 | 191.4 | 102.3 | 77 | 244.3 | 130.6 |
| 38 | 33.5 | 17.9 | 98 | 86.4 | 46.2 | 58 | 139.3 | 74.5 | 18 | 192.3 | 102.8 | 78 | 245.2 | 131.0 |
| 39 | 34.4 | 18.4 | 99 | 87.3 | 46.7 | 59 | 140.2 | 75.0 | 19 | 193.1 | 103.2 | 79 | 246.1 | 131.5 |
| 40 | 35.3 | 18.9 | 100 | 88.2 | 47.1 | 60 | 141.1 | 75.4 | 20 | 194.0 | 103.7 | 80 | 246.9 | 132.0 |
| 41 | 36.2 | 19.3 | 101 | 89.1 | 47.6 | 161 | 142.0 | 75.9 | 221 | 194.9 | 104.2 | 281 | 247.8 | 132.5 |
| 42 | 37.0 | 19.8 | 02 | 90.0 | 48.1 | 62 | 142.9 | 76.4 | 22 | 195.8 | 104.7 | 82 | 248.7 | 132.9 |
| 43 | 37.9 | 20.3 | 03 | 90.8 | 48.6 | 63 | 143.8 | 76.8 | 23 | 196.7 | 105.1 | 83 | 249.6 | 133.4 |
| 44 | 38.8 | 20.7 | 04 | 91.7 | 49.0 | 64 | 144.6 | 77.3 | 24 | 197.6 | 105.6 | 84 | 250.5 | 133.9 |
| 45 | 39.7 | 21.2 | 05 | 92.6 | 49.5 | 65 | 145.5 | 77.8 | 25 | 198.4 | 106.1 | 85 | 251.3 | 134.3 |
| 46 | 40.6 | 21.7 | 06 | 93.5 | 50.0 | 66 | 146.4 | 78.3 | 26 | 199.3 | 106.5 | 86 | 252.2 | 134.8 |
| 47 | 41.5 | 22.2 | 07 | 94.4 | 50.4 | 67 | 147.3 | 78.7 | 27 | 200.2 | 107.0 | 87 | 253.1 | 135.3 |
| 48 | 42.3 | 22.6 | 08 | 95.2 | 50.9 | 68 | 148.2 | 79.2 | 28 | 201.1 | 107.5 | 88 | 254.0 | 135.8 |
| 49 | 43.2 | 23.1 | 09 | 96.1 | 51.4 | 69 | 149.0 | 79.7 | 29 | 202.0 | 107.9 | 89 | 254.9 | 136.2 |
| 50 | 44.1 | 23.6 | 10 | 97.0 | 51.9 | 70 | 149.9 | 80.1 | 30 | 202.8 | 108.4 | 90 | 255.8 | 136.7 |
| 51 | 45.0 | 24.0 | 111 | 97.9 | 52.3 | 171 | 150.8 | 80.6 | 231 | 203.7 | 108.9 | 291 | 256.6 | 137.2 |
| 52 | 45.9 | 24.5 | 12 | 98.8 | 52.8 | 72 | 151.7 | 81.1 | 32 | 204.6 | 109.4 | 92 | 257.5 | 137.6 |
| 53 | 46.7 | 25.0 | 13 | 99.7 | 53.3 | 73 | 152.6 | 81.6 | 33 | 205.5 | 109.8 | 93 | 258.4 | 138.1 |
| 54 | 47.6 | 25.5 | 14 | 100.5 | 53.7 | 74 | 153.5 | 82.0 | 34 | 206.4 | 110.3 | 94 | 259.3 | 138.6 |
| 55 | 48.5 | 25.9 | 15 | 101.4 | 54.2 | 75 | 154.3 | 82.5 | 35 | 207.3 | 110.8 | 95 | 260.2 | 139.1 |
| 56 | 49.4 | 26.4 | 16 | 102.3 | 54.7 | 76 | 155.2 | 83.0 | 36 | 208.1 | 111.2 | 96 | 261.0 | 139.5 |
| 57 | 50.3 | 26.9 | 17 | 103.2 | 55.2 | 77 | 156.1 | 83.4 | 37 | 209.0 | 111.7 | 97 | 261.9 | 140.0 |
| 58 | 51.2 | 27.3 | 18 | 104.1 | 55.6 | 78 | 157.0 | 83.9 | 38 | 209.9 | 112.2 | 98 | 262.8 | 140.5 |
| 59 | 52.0 | 27.8 | 19 | 104.9 | 56.1 | 79 | 157.9 | 84.4 | 39 | 210.8 | 112.7 | 99 | 263.7 | 140.9 |
| 60 | 52.9 | 28.3 | 20 | 105.8 | 56.6 | 80 | 158.7 | 84.9 | 40 | 211.7 | 113.1 | 300 | 264.6 | 141.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

NE. by E. ½ E.    SE. by E. ½ E.    NW. by W. ½ W.    SW. by W. ½ W.    [For 5½ Points.

# TABLE 1.

Difference of Latitude and Departure for 2¾ Points.

| | NNE. ¾ E. | | | NNW. ¾ W. | | | SSE. ¾ E. | | | SSW. ¾ W. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.9 | 0.5 | 61 | 52.3 | 31.4 | 121 | 103.8 | 62.2 | 181 | 155.2 | 93.1 | 241 | 206.7 | 123.9 |
| 2 | 1.7 | 1.0 | 62 | 53.2 | 31.9 | 22 | 104.6 | 62.7 | 82 | 156.1 | 93.6 | 42 | 207.6 | 124.4 |
| 3 | 2.6 | 1.5 | 63 | 54.0 | 32.4 | 23 | 105.5 | 63.2 | 83 | 157.0 | 94.1 | 43 | 208.4 | 124.9 |
| 4 | 3.4 | 2.1 | 64 | 54.9 | 32.9 | 24 | 106.4 | 63.7 | 84 | 157.8 | 94.6 | 44 | 209.3 | 125.4 |
| 5 | 4.3 | 2.6 | 65 | 55.8 | 33.4 | 25 | 107.2 | 64.3 | 85 | 158.7 | 95.1 | 45 | 210.1 | 126.0 |
| 6 | 5.1 | 3.1 | 66 | 56.6 | 33.9 | 26 | 108.1 | 64.8 | 86 | 159.5 | 95.6 | 46 | 211.0 | 126.5 |
| 7 | 6.0 | 3.6 | 67 | 57.5 | 34.4 | 27 | 108.9 | 65.3 | 87 | 160.4 | 96.1 | 47 | 211.9 | 127.0 |
| 8 | 6.9 | 4.1 | 68 | 58.3 | 35.0 | 28 | 109.8 | 65.8 | 88 | 161.3 | 96.7 | 48 | 212.7 | 127.5 |
| 9 | 7.7 | 4.6 | 69 | 59.2 | 35.5 | 29 | 110.6 | 66.3 | 89 | 162.1 | 97.2 | 49 | 213.6 | 128.0 |
| 10 | 8.6 | 5.1 | 70 | 60.0 | 36.0 | 30 | 111.5 | 66.8 | 90 | 163.0 | 97.7 | 50 | 214.4 | 128.5 |
| 11 | 9.4 | 5.7 | 71 | 60.9 | 36.5 | 131 | 112.4 | 67.3 | 191 | 163.8 | 98.2 | 251 | 215.3 | 129.0 |
| 12 | 10.3 | 6.2 | 72 | 61.8 | 37.0 | 32 | 113.2 | 67.9 | 92 | 164.7 | 98.7 | 52 | 216.1 | 129.6 |
| 13 | 11.2 | 6.7 | 73 | 62.6 | 37.5 | 33 | 114.1 | 68.4 | 93 | 165.5 | 99.2 | 53 | 217.0 | 130.1 |
| 14 | 12.0 | 7.2 | 74 | 63.5 | 38.0 | 34 | 114.9 | 68.9 | 94 | 166.4 | 99.7 | 54 | 217.9 | 130.6 |
| 15 | 12.9 | 7.7 | 75 | 64.3 | 38.6 | 35 | 115.8 | 69.4 | 95 | 167.3 | 100.3 | 55 | 218.7 | 131.1 |
| 16 | 13.7 | 8.2 | 76 | 65.2 | 39.1 | 36 | 116.7 | 69.9 | 96 | 168.1 | 100.8 | 56 | 219.6 | 131.6 |
| 17 | 14.6 | 8.7 | 77 | 66.0 | 39.6 | 37 | 117.5 | 70.4 | 97 | 169.0 | 101.3 | 57 | 220.4 | 132.1 |
| 18 | 15.4 | 9.3 | 78 | 66.9 | 40.1 | 38 | 118.4 | 70.9 | 98 | 169.8 | 101.8 | 58 | 221.3 | 132.6 |
| 19 | 16.3 | 9.8 | 79 | 67.8 | 40.6 | 39 | 119.2 | 71.5 | 99 | 170.7 | 102.3 | 59 | 222.2 | 133.2 |
| 20 | 17.2 | 10.3 | 80 | 68.6 | 41.1 | 40 | 120.1 | 72.0 | 200 | 171.5 | 102.8 | 60 | 223.0 | 133.7 |
| 21 | 18.0 | 10.8 | 81 | 69.5 | 41.6 | 141 | 120.9 | 72.5 | 201 | 172.4 | 103.3 | 261 | 223.9 | 134.2 |
| 22 | 18.9 | 11.3 | 82 | 70.3 | 42.2 | 42 | 121.8 | 73.0 | 02 | 173.3 | 103.8 | 62 | 224.7 | 134.7 |
| 23 | 19.7 | 11.8 | 83 | 71.2 | 42.7 | 43 | 122.7 | 73.5 | 03 | 174.1 | 104.4 | 63 | 225.6 | 135.2 |
| 24 | 20.6 | 12.3 | 84 | 72.0 | 43.2 | 44 | 123.5 | 74.0 | 04 | 175.0 | 104.9 | 64 | 226.4 | 135.7 |
| 25 | 21.4 | 12.9 | 85 | 72.9 | 43.7 | 45 | 124.4 | 74.5 | 05 | 175.8 | 105.4 | 65 | 227.3 | 136.2 |
| 26 | 22.3 | 13.4 | 86 | 73.8 | 44.2 | 46 | 125.2 | 75.1 | 06 | 176.7 | 105.9 | 66 | 228.2 | 136.8 |
| 27 | 23.2 | 13.9 | 87 | 74.6 | 44.7 | 47 | 126.1 | 75.6 | 07 | 177.5 | 106.4 | 67 | 229.0 | 137.3 |
| 28 | 24.0 | 14.4 | 88 | 75.5 | 45.2 | 48 | 126.9 | 76.1 | 08 | 178.4 | 106.9 | 68 | 229.9 | 137.8 |
| 29 | 24.9 | 14.9 | 89 | 76.3 | 45.8 | 49 | 127.8 | 76.6 | 09 | 179.3 | 107.4 | 69 | 230.7 | 138.3 |
| 30 | 25.7 | 15.4 | 90 | 77.2 | 46.3 | 50 | 128.7 | 77.1 | 10 | 180.1 | 108.0 | 70 | 231.6 | 138.8 |
| 31 | 26.6 | 15.9 | 91 | 78.1 | 46.8 | 151 | 129.5 | 77.6 | 211 | 181.0 | 108.5 | 271 | 232.4 | 139.3 |
| 32 | 27.4 | 16.5 | 92 | 78.9 | 47.3 | 52 | 130.4 | 78.1 | 12 | 181.8 | 109.0 | 72 | 233.3 | 139.8 |
| 33 | 28.3 | 17.0 | 93 | 79.8 | 47.8 | 53 | 131.2 | 78.7 | 13 | 182.7 | 109.5 | 73 | 234.2 | 140.4 |
| 34 | 29.2 | 17.5 | 94 | 80.6 | 48.3 | 54 | 132.1 | 79.2 | 14 | 183.6 | 110.0 | 74 | 235.0 | 140.9 |
| 35 | 30.0 | 18.0 | 95 | 81.5 | 48.8 | 55 | 132.9 | 79.7 | 15 | 184.4 | 110.5 | 75 | 235.9 | 141.4 |
| 36 | 30.9 | 18.5 | 96 | 82.3 | 49.4 | 56 | 133.8 | 80.2 | 16 | 185.3 | 111.0 | 76 | 236.7 | 141.9 |
| 37 | 31.7 | 19.0 | 97 | 83.2 | 49.9 | 57 | 134.7 | 80.7 | 17 | 186.1 | 111.6 | 77 | 237.6 | 142.4 |
| 38 | 32.6 | 19.5 | 98 | 84.1 | 50.4 | 58 | 135.5 | 81.2 | 18 | 187.0 | 112.1 | 78 | 238.4 | 142.9 |
| 39 | 33.5 | 20.1 | 99 | 84.9 | 50.9 | 59 | 136.4 | 81.7 | 19 | 187.8 | 112.6 | 79 | 239.3 | 143.4 |
| 40 | 34.3 | 20.6 | 100 | 85.8 | 51.4 | 60 | 137.2 | 82.3 | 20 | 188.7 | 113.1 | 80 | 240.2 | 143.9 |
| 41 | 35.2 | 21.1 | 101 | 86.6 | 51.9 | 161 | 138.1 | 82.8 | 221 | 189.6 | 113.6 | 281 | 241.0 | 144.5 |
| 42 | 36.0 | 21.6 | 02 | 87.5 | 52.4 | 62 | 139.0 | 83.3 | 22 | 190.4 | 114.1 | 82 | 241.9 | 145.0 |
| 43 | 36.9 | 22.1 | 03 | 88.3 | 53.0 | 63 | 139.8 | 83.8 | 23 | 191.3 | 114.6 | 83 | 242.7 | 145.5 |
| 44 | 37.7 | 22.6 | 04 | 89.2 | 53.5 | 64 | 140.7 | 84.3 | 24 | 192.1 | 115.2 | 84 | 243.6 | 146.0 |
| 45 | 38.6 | 23.1 | 05 | 90.1 | 54.0 | 65 | 141.5 | 84.8 | 25 | 193.0 | 115.7 | 85 | 244.5 | 146.5 |
| 46 | 39.5 | 23.6 | 06 | 90.9 | 54.5 | 66 | 142.4 | 85.3 | 26 | 193.8 | 116.2 | 86 | 245.3 | 147.0 |
| 47 | 40.3 | 24.2 | 07 | 91.8 | 55.0 | 67 | 143.2 | 85.9 | 27 | 194.7 | 116.7 | 87 | 246.2 | 147.5 |
| 48 | 41.2 | 24.7 | 08 | 92.6 | 55.5 | 68 | 144.1 | 86.4 | 28 | 195.6 | 117.2 | 88 | 247.0 | 148.1 |
| 49 | 42.0 | 25.2 | 09 | 93.5 | 56.0 | 69 | 145.0 | 86.9 | 29 | 196.4 | 117.7 | 89 | 247.9 | 148.6 |
| 50 | 42.9 | 25.7 | 10 | 94.4 | 56.6 | 70 | 145.8 | 87.4 | 30 | 197.3 | 118.2 | 90 | 248.7 | 149.1 |
| 51 | 43.7 | 26.2 | 111 | 95.2 | 57.1 | 171 | 146.7 | 87.9 | 231 | 198.1 | 118.8 | 291 | 249.6 | 149.6 |
| 52 | 44.6 | 26.7 | 12 | 96.1 | 57.6 | 72 | 147.5 | 88.4 | 32 | 199.0 | 119.3 | 92 | 250.5 | 150.1 |
| 53 | 45.5 | 27.2 | 13 | 96.9 | 58.1 | 73 | 148.4 | 88.9 | 33 | 199.9 | 119.8 | 93 | 251.3 | 150.6 |
| 54 | 46.3 | 27.8 | 14 | 97.8 | 58.6 | 74 | 149.2 | 89.5 | 34 | 200.7 | 120.3 | 94 | 252.2 | 151.1 |
| 55 | 47.2 | 28.3 | 15 | 98.6 | 59.1 | 75 | 150.1 | 90.0 | 35 | 201.6 | 120.8 | 95 | 253.0 | 151.7 |
| 56 | 48.0 | 28.8 | 16 | 99.5 | 59.6 | 76 | 151.0 | 90.5 | 36 | 202.4 | 121.3 | 96 | 253.9 | 152.2 |
| 57 | 48.9 | 29.3 | 17 | 100.4 | 60.2 | 77 | 151.8 | 91.0 | 37 | 203.3 | 121.8 | 97 | 254.7 | 152.7 |
| 58 | 49.7 | 29.8 | 18 | 101.2 | 60.7 | 78 | 152.7 | 91.5 | 38 | 204.1 | 122.4 | 98 | 255.6 | 153.2 |
| 59 | 50.6 | 30.3 | 19 | 102.1 | 61.2 | 79 | 153.5 | 92.0 | 39 | 205.0 | 122.9 | 99 | 256.5 | 153.7 |
| 60 | 51.5 | 30.8 | 20 | 102.9 | 61.7 | 80 | 154.4 | 92.5 | 40 | 205.9 | 123.4 | 300 | 257.3 | 154.2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

NE. by E. ¼ E.　　SE. by E. ¼ E.　　NW. by W. ¼ W.　　SW. by W. ¼ W.　　[For 5¼ Points.

TABLE 1. [Page 363

### Difference of Latitude and Departure for 3 Points.

| | NE. by N. | | | NW. by N. | | | SE. by S. | | | SW. by S. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.8 | 0.6 | 61 | 50.7 | 33.9 | 121 | 100.6 | 67.2 | 181 | 150.5 | 100.6 | 241 | 200.4 | 133.9 |
| 2 | 1.7 | 1.1 | 62 | 51.6 | 34.4 | 22 | 101.4 | 67.8 | 82 | 151.3 | 101.1 | 42 | 201.2 | 134.4 |
| 3 | 2.5 | 1.7 | 63 | 52.4 | 35.0 | 23 | 102.3 | 68.3 | 83 | 152.2 | 101.7 | 43 | 202.0 | 135.0 |
| 4 | 3.3 | 2.2 | 64 | 53.2 | 35.6 | 24 | 103.1 | 68.9 | 84 | 153.0 | 102.2 | 44 | 202.9 | 135.6 |
| 5 | 4.2 | 2.8 | 65 | 54.0 | 36.1 | 25 | 103.9 | 69.4 | 85 | 153.8 | 102.8 | 45 | 203.7 | 136.1 |
| 6 | 5.0 | 3.3 | 66 | 54.9 | 36.7 | 26 | 104.8 | 70.0 | 86 | 154.7 | 103.3 | 46 | 204.5 | 136.7 |
| 7 | 5.8 | 3.9 | 67 | 55.7 | 37.2 | 27 | 105.6 | 70.6 | 87 | 155.5 | 103.9 | 47 | 205.4 | 137.2 |
| 8 | 6.7 | 4.4 | 68 | 56.5 | 37.8 | 28 | 106.4 | 71.1 | 88 | 156.3 | 104.4 | 48 | 206.2 | 137.8 |
| 9 | 7.5 | 5.0 | 69 | 57.4 | 38.3 | 29 | 107.3 | 71.7 | 89 | 157.1 | 105.0 | 49 | 207.0 | 138.3 |
| 10 | 8.3 | 5.6 | 70 | 58.2 | 38.9 | 30 | 108.1 | 72.2 | 90 | 158.0 | 105.6 | 50 | 207.9 | 138.9 |
| 11 | 9.1 | 6.1 | 71 | 59.0 | 39.4 | 131 | 108.9 | 72.8 | 191 | 158.8 | 106.1 | 251 | 208.7 | 139.4 |
| 12 | 10.0 | 6.7 | 72 | 59.9 | 40.0 | 32 | 109.8 | 73.3 | 92 | 159.6 | 106.7 | 52 | 209.5 | 140.0 |
| 13 | 10.8 | 7.2 | 73 | 60.7 | 40.6 | 33 | 110.6 | 73.9 | 93 | 160.5 | 107.2 | 53 | 210.4 | 140.6 |
| 14 | 11.6 | 7.8 | 74 | 61.5 | 41.1 | 34 | 111.4 | 74.4 | 94 | 161.3 | 107.8 | 54 | 211.2 | 141.1 |
| 15 | 12.5 | 8.3 | 75 | 62.4 | 41.7 | 35 | 112.2 | 75.0 | 95 | 162.1 | 108.3 | 55 | 212.0 | 141.7 |
| 16 | 13.3 | 8.9 | 76 | 63.2 | 42.2 | 36 | 113.1 | 75.6 | 96 | 163.0 | 108.9 | 56 | 212.9 | 142.2 |
| 17 | 14.1 | 9.4 | 77 | 64.0 | 42.8 | 37 | 113.9 | 76.1 | 97 | 163.8 | 109.4 | 57 | 213.7 | 142.8 |
| 18 | 15.0 | 10.0 | 78 | 64.9 | 43.3 | 38 | 114.7 | 76.7 | 98 | 164.6 | 110.0 | 58 | 214.5 | 143.3 |
| 19 | 15.8 | 10.6 | 79 | 65.7 | 43.9 | 39 | 115.6 | 77.2 | 99 | 165.5 | 110.6 | 59 | 215.4 | 143.9 |
| 20 | 16.6 | 11.1 | 80 | 66.5 | 44.4 | 40 | 116.4 | 77.8 | 200 | 166.3 | 111.1 | 60 | 216.2 | 144.4 |
| 21 | 17.5 | 11.7 | 81 | 67.3 | 45.0 | 141 | 117.2 | 78.3 | 201 | 167.1 | 111.7 | 261 | 217.0 | 145.0 |
| 22 | 18.3 | 12.2 | 82 | 68.2 | 45.6 | 42 | 118.1 | 78.9 | 02 | 168.0 | 112.2 | 62 | 217.8 | 145.6 |
| 23 | 19.1 | 12.8 | 83 | 69.0 | 46.1 | 43 | 118.9 | 79.4 | 03 | 168.8 | 112.8 | 63 | 218.7 | 146.1 |
| 24 | 20.0 | 13.3 | 84 | 69.8 | 46.7 | 44 | 119.7 | 80.0 | 04 | 169.6 | 113.3 | 64 | 219.5 | 146.7 |
| 25 | 20.8 | 13.9 | 85 | 70.7 | 47.2 | 45 | 120.6 | 80.6 | 05 | 170.5 | 113.9 | 65 | 220.3 | 147.2 |
| 26 | 21.6 | 14.4 | 86 | 71.5 | 47.8 | 46 | 121.4 | 81.1 | 06 | 171.3 | 114.4 | 66 | 221.2 | 147.8 |
| 27 | 22.4 | 15.0 | 87 | 72.3 | 48.3 | 47 | 122.2 | 81.7 | 07 | 172.1 | 115.0 | 67 | 222.0 | 148.3 |
| 28 | 23.3 | 15.6 | 88 | 73.2 | 48.9 | 48 | 123.1 | 82.2 | 08 | 172.9 | 115.6 | 68 | 222.8 | 148.9 |
| 29 | 24.1 | 16.1 | 89 | 74.0 | 49.4 | 49 | 123.9 | 82.8 | 09 | 173.8 | 116.1 | 69 | 223.7 | 149.4 |
| 30 | 24.9 | 16.7 | 90 | 74.8 | 50.0 | 50 | 124.7 | 83.3 | 10 | 174.6 | 116.7 | 70 | 224.5 | 150.0 |
| 31 | 25.8 | 17.2 | 91 | 75.7 | 50.6 | 151 | 125.6 | 83.9 | 211 | 175.4 | 117.2 | 271 | 225.3 | 150.6 |
| 32 | 26.6 | 17.8 | 92 | 76.5 | 51.1 | 52 | 126.4 | 84.4 | 12 | 176.3 | 117.8 | 72 | 226.2 | 151.1 |
| 33 | 27.4 | 18.3 | 93 | 77.3 | 51.7 | 53 | 127.2 | 85.0 | 13 | 177.1 | 118.3 | 73 | 227.0 | 151.7 |
| 34 | 28.3 | 18.9 | 94 | 78.2 | 52.2 | 54 | 128.0 | 85.6 | 14 | 177.9 | 118.9 | 74 | 227.8 | 152.2 |
| 35 | 29.1 | 19.4 | 95 | 79.0 | 52.8 | 55 | 128.9 | 86.1 | 15 | 178.8 | 119.4 | 75 | 228.7 | 152.8 |
| 36 | 29.9 | 20.0 | 96 | 79.8 | 53.3 | 56 | 129.7 | 86.7 | 16 | 179.6 | 120.0 | 76 | 229.5 | 153.3 |
| 37 | 30.8 | 20.6 | 97 | 80.7 | 53.9 | 57 | 130.5 | 87.2 | 17 | 180.4 | 120.6 | 77 | 230.3 | 153.9 |
| 38 | 31.6 | 21.1 | 98 | 81.5 | 54.4 | 58 | 131.4 | 87.8 | 18 | 181.3 | 121.1 | 78 | 231.1 | 154.4 |
| 39 | 32.4 | 21.7 | 99 | 82.3 | 55.0 | 59 | 132.2 | 88.3 | 19 | 182.1 | 121.7 | 79 | 232.0 | 155.0 |
| 40 | 33.3 | 22.2 | 100 | 83.1 | 55.6 | 60 | 133.0 | 88.9 | 20 | 182.9 | 122.2 | 80 | 232.8 | 155.6 |
| 41 | 34.1 | 22.8 | 101 | 84.0 | 56.1 | 161 | 133.9 | 89.4 | 221 | 183.8 | 122.8 | 281 | 233.6 | 156.1 |
| 42 | 34.9 | 23.3 | 02 | 84.8 | 56.7 | 62 | 134.7 | 90.0 | 22 | 184.6 | 123.3 | 82 | 234.5 | 156.7 |
| 43 | 35.8 | 23.9 | 03 | 85.6 | 57.2 | 63 | 135.5 | 90.6 | 23 | 185.4 | 123.9 | 83 | 235.3 | 157.2 |
| 44 | 36.6 | 24.4 | 04 | 86.5 | 57.8 | 64 | 136.4 | 91.1 | 24 | 186.2 | 124.4 | 84 | 236.1 | 157.8 |
| 45 | 37.4 | 25.0 | 05 | 87.3 | 58.3 | 65 | 137.2 | 91.7 | 25 | 187.1 | 125.0 | 85 | 237.0 | 158.3 |
| 46 | 38.2 | 25.6 | 06 | 88.1 | 58.9 | 66 | 138.0 | 92.2 | 26 | 187.9 | 125.6 | 86 | 237.8 | 158.9 |
| 47 | 39.1 | 26.1 | 07 | 89.0 | 59.4 | 67 | 138.9 | 92.8 | 27 | 188.7 | 126.1 | 87 | 238.6 | 159.4 |
| 48 | 39.9 | 26.7 | 08 | 89.8 | 60.0 | 68 | 139.7 | 93.3 | 28 | 189.6 | 126.7 | 88 | 239.5 | 160.0 |
| 49 | 40.7 | 27.2 | 09 | 90.6 | 60.6 | 69 | 140.5 | 93.9 | 29 | 190.4 | 127.2 | 89 | 240.3 | 160.6 |
| 50 | 41.6 | 27.8 | 10 | 91.5 | 61.1 | 70 | 141.3 | 94.4 | 30 | 191.2 | 127.8 | 90 | 241.1 | 161.1 |
| 51 | 42.4 | 28.3 | 111 | 92.3 | 61.7 | 171 | 142.2 | 95.0 | 231 | 192.1 | 128.3 | 291 | 242.0 | 161.7 |
| 52 | 43.2 | 28.9 | 12 | 93.1 | 62.2 | 72 | 143.0 | 95.6 | 32 | 192.9 | 128.9 | 92 | 242.8 | 162.2 |
| 53 | 44.1 | 29.4 | 13 | 94.0 | 62.8 | 73 | 143.8 | 96.1 | 33 | 193.7 | 129.4 | 93 | 243.6 | 162.8 |
| 54 | 44.9 | 30.0 | 14 | 94.8 | 63.3 | 74 | 144.7 | 96.7 | 34 | 194.6 | 130.0 | 94 | 244.5 | 163.3 |
| 55 | 45.7 | 30.6 | 15 | 95.6 | 63.9 | 75 | 145.5 | 97.2 | 35 | 195.4 | 130.6 | 95 | 245.3 | 163.9 |
| 56 | 46.6 | 31.1 | 16 | 96.5 | 64.4 | 76 | 146.3 | 97.8 | 36 | 196.2 | 131.1 | 96 | 246.1 | 164.4 |
| 57 | 47.4 | 31.7 | 17 | 97.3 | 65.0 | 77 | 147.2 | 98.3 | 37 | 197.1 | 131.7 | 97 | 246.9 | 165.0 |
| 58 | 48.2 | 32.2 | 18 | 98.1 | 65.6 | 78 | 148.0 | 98.9 | 38 | 197.9 | 132.2 | 98 | 247.8 | 165.6 |
| 59 | 49.1 | 32.8 | 19 | 98.9 | 66.1 | 79 | 148.8 | 99.4 | 39 | 198.7 | 132.8 | 99 | 248.6 | 166.1 |
| 60 | 49.9 | 33.3 | 20 | 99.8 | 66.7 | 80 | 149.7 | 100.0 | 40 | 199.6 | 133.3 | 300 | 249.4 | 166.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| NE. by E. | SE. by E. | NW. by W. | SW. by W. | [For 5 Points. |
|---|---|---|---|---|

# TABLE 1.

### Difference of Latitude and Departure for 3¼ Points.

| NE. ¾ N. | | | NW. ¾ N. | | | SE. ¾ S. | | | SW. ¾ S. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.8 | 0.6 | 61 | 49.0 | 36.3 | 121 | 97.2 | 72.1 | 181 | 145.4 | 107.8 | 241 | 193.6 | 143.6 |
| 2 | 1.6 | 1.2 | 62 | 49.8 | 36.9 | 22 | 98.0 | 72.7 | 82 | 146.2 | 108.4 | 42 | 194.4 | 144.2 |
| 3 | 2.4 | 1.8 | 63 | 50.6 | 37.5 | 23 | 98.8 | 73.3 | 83 | 147.0 | 109.0 | 43 | 195.2 | 144.8 |
| 4 | 3.2 | 2.4 | 64 | 51.4 | 38.1 | 24 | 99.6 | 73.9 | 84 | 147.8 | 109.6 | 44 | 196.0 | 145.4 |
| 5 | 4.0 | 3.0 | 65 | 52.2 | 38.7 | 25 | 100.4 | 74.5 | 85 | 148.6 | 110.2 | 45 | 196.8 | 145.9 |
| 6 | 4.8 | 3.6 | 66 | 53.0 | 39.3 | 26 | 101.2 | 75.1 | 86 | 149.4 | 110.8 | 46 | 197.6 | 146.5 |
| 7 | 5.6 | 4.2 | 67 | 53.8 | 39.9 | 27 | 102.0 | 75.7 | 87 | 150.2 | 111.4 | 47 | 198.4 | 147.1 |
| 8 | 6.4 | 4.8 | 68 | 54.6 | 40.5 | 28 | 102.8 | 76.2 | 88 | 151.0 | 112.0 | 48 | 199.2 | 147.7 |
| 9 | 7.2 | 5.4 | 69 | 55.4 | 41.1 | 29 | 103.6 | 76.8 | 89 | 151.8 | 112.6 | 49 | 200.0 | 148.3 |
| 10 | 8.0 | 6.0 | 70 | 56.2 | 41.7 | 30 | 104.4 | 77.4 | 90 | 152.6 | 113.2 | 50 | 200.8 | 148.9 |
| 11 | 8.8 | 6.6 | 71 | 57.0 | 42.3 | 131 | 105.2 | 78.0 | 191 | 153.4 | 113.8 | 251 | 201.6 | 149.5 |
| 12 | 9.6 | 7.1 | 72 | 57.8 | 42.9 | 32 | 106.0 | 78.6 | 92 | 154.2 | 114.4 | 52 | 202.4 | 150.1 |
| 13 | 10.4 | 7.7 | 73 | 58.6 | 43.5 | 33 | 106.8 | 79.2 | 93 | 155.0 | 115.0 | 53 | 203.2 | 150.7 |
| 14 | 11.2 | 8.3 | 74 | 59.4 | 44.1 | 34 | 107.6 | 79.8 | 94 | 155.8 | 115.6 | 54 | 204.0 | 151.3 |
| 15 | 12.0 | 8.9 | 75 | 60.2 | 44.7 | 35 | 108.4 | 80.4 | 95 | 156.6 | 116.2 | 55 | 204.8 | 151.9 |
| 16 | 12.9 | 9.5 | 76 | 61.0 | 45.3 | 36 | 109.2 | 81.0 | 96 | 157.4 | 116.8 | 56 | 205.6 | 152.5 |
| 17 | 13.7 | 10.1 | 77 | 61.8 | 45.9 | 37 | 110.0 | 81.6 | 97 | 158.2 | 117.4 | 57 | 206.4 | 153.1 |
| 18 | 14.5 | 10.7 | 78 | 62.7 | 46.5 | 38 | 110.8 | 82.2 | 98 | 159.0 | 117.9 | 58 | 207.2 | 153.7 |
| 19 | 15.3 | 11.3 | 79 | 63.5 | 47.1 | 39 | 111.6 | 82.8 | 99 | 159.8 | 118.5 | 59 | 208.0 | 154.3 |
| 20 | 16.1 | 11.9 | 80 | 64.3 | 47.7 | 40 | 112.4 | 83.4 | 200 | 160.6 | 119.1 | 60 | 208.8 | 154.9 |
| 21 | 16.9 | 12.5 | 81 | 65.1 | 48.3 | 141 | 113.3 | 84.0 | 201 | 161.4 | 119.7 | 261 | 209.6 | 155.5 |
| 22 | 17.7 | 13.1 | 82 | 65.9 | 48.8 | 42 | 114.1 | 84.6 | 02 | 162.2 | 120.3 | 62 | 210.4 | 156.1 |
| 23 | 18.5 | 13.7 | 83 | 66.7 | 49.4 | 43 | 114.9 | 85.2 | 03 | 163.1 | 120.9 | 63 | 211.2 | 156.7 |
| 24 | 19.3 | 14.3 | 84 | 67.5 | 50.0 | 44 | 115.7 | 85.8 | 04 | 163.9 | 121.5 | 64 | 212.0 | 157.3 |
| 25 | 20.1 | 14.9 | 85 | 68.3 | 50.6 | 45 | 116.5 | 86.4 | 05 | 164.7 | 122.1 | 65 | 212.8 | 157.9 |
| 26 | 20.9 | 15.5 | 86 | 69.1 | 51.2 | 46 | 117.3 | 87.0 | 06 | 165.5 | 122.7 | 66 | 213.7 | 158.5 |
| 27 | 21.7 | 16.1 | 87 | 69.9 | 51.8 | 47 | 118.1 | 87.6 | 07 | 166.3 | 123.3 | 67 | 214.5 | 159.1 |
| 28 | 22.5 | 16.7 | 88 | 70.7 | 52.4 | 48 | 118.9 | 88.2 | 08 | 167.1 | 123.9 | 68 | 215.3 | 159.6 |
| 29 | 23.3 | 17.3 | 89 | 71.5 | 53.0 | 49 | 119.7 | 88.8 | 09 | 167.9 | 124.5 | 69 | 216.1 | 160.2 |
| 30 | 24.1 | 17.9 | 90 | 72.3 | 53.6 | 50 | 120.5 | 89.4 | 10 | 168.7 | 125.1 | 70 | 216.9 | 160.8 |
| 31 | 24.9 | 18.5 | 91 | 73.1 | 54.2 | 151 | 121.3 | 90.0 | 211 | 169.5 | 125.7 | 271 | 217.7 | 161.4 |
| 32 | 25.7 | 19.1 | 92 | 73.9 | 54.8 | 52 | 122.1 | 90.5 | 12 | 170.3 | 126.3 | 72 | 218.5 | 162.0 |
| 33 | 26.5 | 19.7 | 93 | 74.7 | 55.4 | 53 | 122.9 | 91.1 | 13 | 171.1 | 126.9 | 73 | 219.3 | 162.6 |
| 34 | 27.3 | 20.3 | 94 | 75.5 | 56.0 | 54 | 123.7 | 91.7 | 14 | 171.9 | 127.5 | 74 | 220.1 | 163.2 |
| 35 | 28.1 | 20.8 | 95 | 76.3 | 56.6 | 55 | 124.5 | 92.3 | 15 | 172.7 | 128.1 | 75 | 220.9 | 163.8 |
| 36 | 28.9 | 21.4 | 96 | 77.1 | 57.2 | 56 | 125.3 | 92.9 | 16 | 173.5 | 128.7 | 76 | 221.7 | 164.4 |
| 37 | 29.7 | 22.0 | 97 | 77.9 | 57.8 | 57 | 126.1 | 93.5 | 17 | 174.3 | 129.3 | 77 | 222.5 | 165.0 |
| 38 | 30.5 | 22.6 | 98 | 78.7 | 58.4 | 58 | 126.9 | 94.1 | 18 | 175.1 | 129.9 | 78 | 223.3 | 165.6 |
| 39 | 31.3 | 23.2 | 99 | 79.5 | 59.0 | 59 | 127.7 | 94.7 | 19 | 175.9 | 130.5 | 79 | 224.1 | 166.2 |
| 40 | 32.1 | 23.8 | 100 | 80.3 | 59.6 | 60 | 128.5 | 95.3 | 20 | 176.7 | 131.1 | 80 | 224.9 | 166.8 |
| 41 | 32.9 | 24.4 | 101 | 81.1 | 60.2 | 161 | 129.3 | 95.9 | 221 | 177.5 | 131.6 | 281 | 225.7 | 167.4 |
| 42 | 33.7 | 25.0 | 02 | 81.9 | 60.8 | 62 | 130.1 | 96.5 | 22 | 178.3 | 132.2 | 82 | 226.5 | 168.0 |
| 43 | 34.5 | 25.6 | 03 | 82.7 | 61.4 | 63 | 130.9 | 97.1 | 23 | 179.1 | 132.8 | 83 | 227.3 | 168.6 |
| 44 | 35.3 | 26.2 | 04 | 83.5 | 62.0 | 64 | 131.7 | 97.7 | 24 | 179.9 | 133.4 | 84 | 228.1 | 169.2 |
| 45 | 36.1 | 26.8 | 05 | 84.3 | 62.5 | 65 | 132.5 | 98.3 | 25 | 180.7 | 134.0 | 85 | 228.9 | 169.8 |
| 46 | 36.9 | 27.4 | 06 | 85.1 | 63.1 | 66 | 133.3 | 98.9 | 26 | 181.5 | 134.6 | 86 | 229.7 | 170.4 |
| 47 | 37.8 | 28.0 | 07 | 85.9 | 63.7 | 67 | 134.1 | 99.5 | 27 | 182.3 | 135.2 | 87 | 230.5 | 171.0 |
| 48 | 38.6 | 28.6 | 08 | 86.7 | 64.3 | 68 | 134.9 | 100.1 | 28 | 183.1 | 135.8 | 88 | 231.3 | 171.6 |
| 49 | 39.4 | 29.2 | 09 | 87.5 | 64.9 | 69 | 135.7 | 100.7 | 29 | 183.9 | 136.4 | 89 | 232.1 | 172.2 |
| 50 | 40.2 | 29.8 | 10 | 88.4 | 65.5 | 70 | 136.5 | 101.3 | 30 | 184.7 | 137.0 | 90 | 232.9 | 172.8 |
| 51 | 41.0 | 30.4 | 111 | 89.2 | 66.1 | 171 | 137.3 | 101.9 | 231 | 185.5 | 137.6 | 291 | 233.7 | 173.3 |
| 52 | 41.8 | 31.0 | 12 | 90.0 | 66.7 | 72 | 138.2 | 102.5 | 32 | 186.3 | 138.2 | 92 | 234.5 | 173.9 |
| 53 | 42.6 | 31.6 | 13 | 90.8 | 67.3 | 73 | 139.0 | 103.1 | 33 | 187.1 | 138.8 | 93 | 235.3 | 174.5 |
| 54 | 43.4 | 32.2 | 14 | 91.6 | 67.9 | 74 | 139.8 | 103.7 | 34 | 188.0 | 139.4 | 94 | 236.1 | 175.1 |
| 55 | 44.2 | 32.8 | 15 | 92.4 | 68.5 | 75 | 140.6 | 104.2 | 35 | 188.8 | 140.0 | 95 | 236.9 | 175.7 |
| 56 | 45.0 | 33.4 | 16 | 93.2 | 69.1 | 76 | 141.4 | 104.8 | 36 | 189.6 | 140.6 | 96 | 237.7 | 176.3 |
| 57 | 45.8 | 34.0 | 17 | 94.0 | 69.7 | 77 | 142.2 | 105.4 | 37 | 190.4 | 141.2 | 97 | 238.6 | 176.9 |
| 58 | 46.6 | 34.6 | 18 | 94.8 | 70.3 | 78 | 143.0 | 106.0 | .38 | 191.2 | 141.8 | 98 | 239.4 | 177.5 |
| 59 | 47.4 | 35.1 | 19 | 95.6 | 70.9 | 79 | 143.8 | 106.6 | 39 | 192.0 | 142.4 | 99 | 240.2 | 178.1 |
| 60 | 48.2 | 35.7 | 20 | 96.4 | 71.5 | 80 | 144.6 | 107.2 | 40 | 192.8 | 143.0 | 300 | 241.0 | 178.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| NE. ¾ E. | SE. ¾ E. | NW. ¾ W. | SW. ¾ W. | [For 4¼ Points. |

# TABLE 1. [Page 365

Difference of Latitude and Departure for 3½ Points.

| NE. ½ N. | | | NW. ½ N. | | | SE. ½ S. | | | SW. ½ S. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.8 | 0.6 | 61 | 47.2 | 38.7 | 121 | 93.5 | 76.8 | 181 | 139.9 | 114.8 | 241 | 186.3 | 152.9 |
| 2 | 1.5 | 1.3 | 62 | 47.9 | 39.3 | 22 | 94.3 | 77.4 | 82 | 140.7 | 115.5 | 42 | 187.1 | 153.5 |
| 3 | 2.3 | 1.9 | 63 | 48.7 | 40.0 | 23 | 95.1 | 78.0 | 83 | 141.5 | 116.1 | 43 | 187.8 | 154.2 |
| 4 | 3.1 | 2.5 | 64 | 49.5 | 40.6 | 24 | 95.9 | 78.7 | 84 | 142.2 | 116.7 | 44 | 188.6 | 154.8 |
| 5 | 3.9 | 3.2 | 65 | 50.2 | 41.2 | 25 | 96.6 | 79.3 | 85 | 143.0 | 117.4 | 45 | 189.4 | 155.4 |
| 6 | 4.6 | 3.8 | 66 | 51.0 | 41.9 | 26 | 97.4 | 79.9 | 86 | 143.8 | 118.0 | 46 | 190.2 | 156.1 |
| 7 | 5.4 | 4.4 | 67 | 51.8 | 42.5 | 27 | 98.2 | 80.6 | 87 | 144.6 | 118.6 | 47 | 190.9 | 156.7 |
| 8 | 6.2 | 5.1 | 68 | 52.6 | 43.1 | 28 | 98.9 | 81.2 | 88 | 145.3 | 119.3 | 48 | 191.7 | 157.3 |
| 9 | 7.0 | 5.7 | 69 | 53.3 | 43.8 | 29 | 99.7 | 81.8 | 89 | 146.1 | 119.9 | 49 | 192.5 | 158.0 |
| 10 | 7.7 | 6.3 | 70 | 54.1 | 44.4 | 30 | 100.5 | 82.5 | 90 | 146.9 | 120.5 | 50 | 193.3 | 158.6 |
| 11 | 8.5 | 7.0 | 71 | 54.9 | 45.0 | 131 | 101.3 | 83.1 | 191 | 147.6 | 121.2 | 251 | 194.0 | 159.2 |
| 12 | 9.3 | 7.6 | 72 | 55.7 | 45.7 | 32 | 102.0 | 83.7 | 92 | 148.4 | 121.8 | 52 | 194.8 | 159.9 |
| 13 | 10.0 | 8.2 | 73 | 56.4 | 46.3 | 33 | 102.8 | 84.4 | 93 | 149.2 | 122.4 | 53 | 195.6 | 160.5 |
| 14 | 10.8 | 8.9 | 74 | 57.2 | 46.9 | 34 | 103.6 | 85.0 | 94 | 150.0 | 123.1 | 54 | 196.3 | 161.1 |
| 15 | 11.6 | 9.5 | 75 | 58.0 | 47.6 | 35 | 104.4 | 85.6 | 95 | 150.7 | 123.7 | 55 | 197.1 | 161.8 |
| 16 | 12.4 | 10.2 | 76 | 58.7 | 48.2 | 36 | 105.1 | 86.3 | 96 | 151.5 | 124.3 | 56 | 197.9 | 162.4 |
| 17 | 13.1 | 10.8 | 77 | 59.5 | 48.8 | 37 | 105.9 | 86.9 | 97 | 152.3 | 125.0 | 57 | 198.7 | 163.0 |
| 18 | 13.9 | 11.4 | 78 | 60.3 | 49.5 | 38 | 106.7 | 87.5 | 98 | 153.1 | 125.6 | 58 | 199.4 | 163.7 |
| 19 | 14.7 | 12.1 | 79 | 61.1 | 50.1 | 39 | 107.4 | 88.2 | 99 | 153.8 | 126.2 | 59 | 200.2 | 164.3 |
| 20 | 15.5 | 12.7 | 80 | 61.8 | 50.8 | 40 | 108.2 | 88.8 | 200 | 154.6 | 126.9 | 60 | 201.0 | 164.9 |
| 21 | 16.2 | 13.3 | 81 | 62.6 | 51.4 | 141 | 109.0 | 89.4 | 201 | 155.4 | 127.5 | 261 | 201.8 | 165.6 |
| 22 | 17.0 | 14.0 | 82 | 63.4 | 52.0 | 42 | 109.8 | 90.1 | 02 | 156.1 | 128.1 | 62 | 202.5 | 166.2 |
| 23 | 17.8 | 14.6 | 83 | 64.2 | 52.7 | 43 | 110.5 | 90.7 | 03 | 156.9 | 128.8 | 63 | 203.3 | 166.8 |
| 24 | 18.6 | 15.2 | 84 | 64.9 | 53.3 | 44 | 111.3 | 91.4 | 04 | 157.7 | 129.4 | 64 | 204.1 | 167.5 |
| 25 | 19.3 | 15.9 | 85 | 65.7 | 53.9 | 45 | 112.1 | 92.0 | 05 | 158.5 | 130.1 | 65 | 204.8 | 168.1 |
| 26 | 20.1 | 16.5 | 86 | 66.5 | 54.6 | 46 | 112.9 | 92.6 | 06 | 159.2 | 130.7 | 66 | 205.6 | 168.7 |
| 27 | 20.9 | 17.1 | 87 | 67.3 | 55.2 | 47 | 113.6 | 93.3 | 07 | 160.0 | 131.3 | 67 | 206.4 | 169.4 |
| 28 | 21.6 | 17.8 | 88 | 68.0 | 55.8 | 48 | 114.4 | 93.9 | 08 | 160.8 | 132.0 | 68 | 207.2 | 170.0 |
| 29 | 22.4 | 18.4 | 89 | 68.8 | 56.5 | 49 | 115.2 | 94.5 | 09 | 161.6 | 132.6 | 69 | 207.9 | 170.7 |
| 30 | 23.2 | 19.0 | 90 | 69.6 | 57.1 | 50 | 116.0 | 95.2 | 10 | 162.3 | 133.2 | 70 | 208.7 | 171.3 |
| 31 | 24.0 | 19.7 | 91 | 70.3 | 57.7 | 151 | 116.7 | 95.8 | 211 | 163.1 | 133.9 | 271 | 209.5 | 171.9 |
| 32 | 24.7 | 20.3 | 92 | 71.1 | 58.4 | 52 | 117.5 | 96.4 | 12 | 163.9 | 134.5 | 72 | 210.3 | 172.6 |
| 33 | 25.5 | 20.9 | 93 | 71.9 | 59.0 | 53 | 118.3 | 97.1 | 13 | 164.7 | 135.1 | 73 | 211.0 | 173.2 |
| 34 | 26.3 | 21.6 | 94 | 72.7 | 59.6 | 54 | 119.0 | 97.7 | 14 | 165.4 | 135.8 | 74 | 211.8 | 173.8 |
| 35 | 27.1 | 22.2 | 95 | 73.4 | 60.3 | 55 | 119.8 | 98.3 | 15 | 166.2 | 136.4 | 75 | 212.6 | 174.5 |
| 36 | 27.8 | 22.8 | 96 | 74.2 | 60.9 | 56 | 120.6 | 99.0 | 16 | 167.0 | 137.0 | 76 | 213.4 | 175.1 |
| 37 | 28.6 | 23.5 | 97 | 75.0 | 61.5 | 57 | 121.4 | 99.6 | 17 | 167.7 | 137.7 | 77 | 214.1 | 175.7 |
| 38 | 29.4 | 24.1 | 98 | 75.8 | 62.2 | 58 | 122.1 | 100.2 | 18 | 168.5 | 138.3 | 78 | 214.9 | 176.4 |
| 39 | 30.1 | 24.7 | 99 | 76.5 | 62.8 | 59 | 122.9 | 100.9 | 19 | 169.3 | 138.9 | 79 | 215.7 | 177.0 |
| 40 | 30.9 | 25.4 | 100 | 77.3 | 63.4 | 60 | 123.7 | 101.5 | 20 | 170.1 | 139.6 | 80 | 216.4 | 177.6 |
| 41 | 31.7 | 26.0 | 101 | 78.1 | 64.1 | 161 | 124.5 | 102.1 | 221 | 170.8 | 140.2 | 281 | 217.2 | 178.3 |
| 42 | 32.5 | 26.6 | 02 | 78.8 | 64.7 | 62 | 125.2 | 102.8 | 22 | 171.6 | 140.8 | 82 | 218.0 | 178.9 |
| 43 | 33.2 | 27.3 | 03 | 79.6 | 65.3 | 63 | 126.0 | 103.4 | 23 | 172.4 | 141.5 | 83 | 218.8 | 179.5 |
| 44 | 34.0 | 27.9 | 04 | 80.4 | 66.0 | 64 | 126.8 | 104.0 | 24 | 173.2 | 142.1 | 84 | 219.5 | 180.2 |
| 45 | 34.8 | 28.5 | 05 | 81.2 | 66.6 | 65 | 127.5 | 104.7 | 25 | 173.9 | 142.7 | 85 | 220.3 | 180.8 |
| 46 | 35.6 | 29.2 | 06 | 81.9 | 67.2 | 66 | 128.3 | 105.3 | 26 | 174.7 | 143.4 | 86 | 221.1 | 181.4 |
| 47 | 36.3 | 29.8 | 07 | 82.7 | 67.9 | 67 | 129.1 | 105.9 | 27 | 175.5 | 144.0 | 87 | 221.9 | 182.1 |
| 48 | 37.1 | 30.5 | 08 | 83.5 | 68.5 | 68 | 129.9 | 106.6 | 28 | 176.2 | 144.6 | 88 | 222.6 | 182.7 |
| 49 | 37.9 | 31.1 | 09 | 84.3 | 69.1 | 69 | 130.6 | 107.2 | 29 | 177.0 | 145.3 | 89 | 223.4 | 183.3 |
| 50 | 38.7 | 31.7 | 10 | 85.0 | 69.8 | 70 | 131.4 | 107.8 | 30 | 177.8 | 145.9 | 90 | 224.2 | 184.0 |
| 51 | 39.4 | 32.4 | 111 | 85.8 | 70.4 | 171 | 132.2 | 108.5 | 231 | 178.6 | 146.5 | 291 | 224.9 | 184.6 |
| 52 | 40.2 | 33.0 | 12 | 86.6 | 71.1 | 72 | 133.0 | 109.1 | 32 | 179.3 | 147.2 | 92 | 225.7 | 185.2 |
| 53 | 41.0 | 33.6 | 13 | 87.4 | 71.7 | 73 | 133.7 | 109.8 | 33 | 180.1 | 147.8 | 93 | 226.5 | 185.9 |
| 54 | 41.7 | 34.3 | 14 | 88.1 | 72.3 | 74 | 134.5 | 110.4 | 34 | 180.9 | 148.4 | 94 | 227.3 | 186.5 |
| 55 | 42.5 | 34.9 | 15 | 88.9 | 73.0 | 75 | 135.3 | 111.0 | 35 | 181.7 | 149.1 | 95 | 228.0 | 187.1 |
| 56 | 43.3 | 35.5 | 16 | 89.7 | 73.6 | 76 | 136.0 | 111.7 | 36 | 182.4 | 149.7 | 96 | 228.8 | 187.8 |
| 57 | 44.1 | 36.2 | 17 | 90.4 | 74.2 | 77 | 136.8 | 112.3 | 37 | 183.2 | 150.4 | 97 | 229.6 | 188.4 |
| 58 | 44.8 | 36.8 | 18 | 91.2 | 74.9 | 78 | 137.6 | 112.9 | 38 | 184.0 | 151.0 | 98 | 230.4 | 189.0 |
| 59 | 45.6 | 37.4 | 19 | 92.0 | 75.5 | 79 | 138.4 | 113.6 | 39 | 184.7 | 151.6 | 99 | 231.1 | 189.7 |
| 60 | 46.4 | 38.1 | 20 | 92.8 | 76.1 | 80 | 139.1 | 114.2 | 40 | 185.5 | 152.3 | 300 | 231.9 | 190.3 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |
| NE. ½ E. | | | SE. ½ E. | | | NW. ½ W. | | | SW. ½ W. | | | [For 4½ Points. | | |

# TABLE 1.

Difference of Latitude and Departure for 3¾ Points.

| | NE. ¼ N. | | | NW. ¼ N. | | | SE. ¼ S. | | | SW. ¼ S. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.7 | 0.7 | 61 | 45.2 | 41.0 | 121 | 89.7 | 81.3 | 181 | 134.1 | 121.6 | 241 | 178.6 | 161.8 |
| 2 | 1.5 | 1.3 | 62 | 45.9 | 41.6 | 22 | 90.4 | 81.9 | 82 | 134.9 | 122.2 | 42 | 179.3 | 162.5 |
| 3 | 2.2 | 2.0 | 63 | 46.7 | 42.3 | 23 | 91.1 | 82.6 | 83 | 135.6 | 122.9 | 43 | 180.1 | 163.2 |
| 4 | 3.0 | 2.7 | 64 | 47.4 | 43.0 | 24 | 91.9 | 83.3 | 84 | 136.3 | 123.6 | 44 | 180.8 | 163.9 |
| 5 | 3.7 | 3.4 | 65 | 48.2 | 43.7 | 25 | 92.6 | 83.9 | 85 | 137.1 | 124.2 | 45 | 181.5 | 164.5 |
| 6 | 4.4 | 4.0 | 66 | 48.9 | 44.3 | 26 | 93.4 | 84.6 | 86 | 137.8 | 124.9 | 46 | 182.3 | 165.2 |
| 7 | 5.2 | 4.7 | 67 | 49.6 | 45.0 | 27 | 94.1 | 85.3 | 87 | 138.6 | 125.6 | 47 | 183.0 | 165.9 |
| 8 | 5.9 | 5.4 | 68 | 50.4 | 45.7 | 28 | 94.8 | 86.0 | 88 | 139.3 | 126.3 | 48 | 183.8 | 166.5 |
| 9 | 6.7 | 6.0 | 69 | 51.1 | 46.3 | 29 | 95.6 | 86.6 | 89 | 140.0 | 126.9 | 49 | 184.5 | 167.2 |
| 10 | 7.4 | 6.7 | 70 | 51.9 | 47.0 | 30 | 96.3 | 87.3 | 90 | 140.8 | 127.6 | 50 | 185.2 | 167.9 |
| 11 | 8.2 | 7.4 | 71 | 52.6 | 47.7 | 131 | 97.1 | 88.0 | 191 | 141.5 | 128.3 | 251 | 186.0 | 168.6 |
| 12 | 8.9 | 8.1 | 72 | 53.3 | 48.4 | 32 | 97.8 | 88.6 | 92 | 142.8 | 128.9 | 52 | 186.7 | 169.2 |
| 13 | 9.6 | 8.7 | 73 | 54.1 | 49.0 | 33 | 98.5 | 89.3 | 93 | 143.0 | 129.6 | 53 | 187.5 | 169.9 |
| 14 | 10.4 | 9.4 | 74 | 54.8 | 49.7 | 34 | 99.3 | 90.0 | 94 | 143.7 | 130.3 | 54 | 188.2 | 170.6 |
| 15 | 11.1 | 10.1 | 75 | 55.6 | 50.4 | 35 | 100.0 | 90.7 | 95 | 144.5 | 131.0 | 55 | 188.9 | 171.2 |
| 16 | 11.9 | 10.7 | 76 | 56.3 | 51.0 | 36 | 100.8 | 91.3 | 96 | 145.2 | 131.6 | 56 | 189.7 | 171.9 |
| 17 | 12.6 | 11.4 | 77 | 57.1 | 51.7 | 37 | 101.5 | 92.0 | 97 | 146.0 | 132.3 | 57 | 190.4 | 172.6 |
| 18 | 13.3 | 12.1 | 78 | 57.8 | 52.4 | 38 | 102.3 | 92.7 | 98 | 146.7 | 133.0 | 58 | 191.2 | 173.3 |
| 19 | 14.1 | 12.8 | 79 | 58.5 | 53.1 | 39 | 103.0 | 93.3 | 99 | 147.4 | 133.6 | 59 | 191.9 | 173.9 |
| 20 | 14.8 | 13.4 | 80 | 59.3 | 53.7 | 40 | 103.7 | 94.0 | 200 | 148.2 | 134.3 | 60 | 192.6 | 174.6 |
| 21 | 15.6 | 14.1 | 81 | 60.0 | 54.4 | 141 | 104.5 | 94.7 | 201 | 148.9 | 135.0 | 261 | 193.4 | 175.3 |
| 22 | 16.3 | 14.8 | 82 | 60.8 | 55.1 | 42 | 105.2 | 95.4 | 02 | 149.7 | 135.7 | 62 | 194.1 | 175.9 |
| 23 | 17.0 | 15.4 | 83 | 61.5 | 55.7 | 43 | 106.0 | 96.0 | 03 | 150.4 | 136.3 | 63 | 194.9 | 176.6 |
| 24 | 17.8 | 16.1 | 84 | 62.2 | 56.4 | 44 | 106.7 | 96.7 | 04 | 151.2 | 137.0 | 64 | 195.6 | 177.3 |
| 25 | 18.5 | 16.8 | 85 | 63.0 | 57.1 | 45 | 107.4 | 97.4 | 05 | 151.9 | 137.7 | 65 | 196.4 | 178.0 |
| 26 | 19.3 | 17.5 | 86 | 63.7 | 57.8 | 46 | 108.2 | 98.0 | 06 | 152.6 | 138.3 | 66 | 197.1 | 178.6 |
| 27 | 20.0 | 18.1 | 87 | 64.5 | 58.4 | 47 | 108.9 | 98.7 | 07 | 153.4 | 139.0 | 67 | 197.8 | 179.3 |
| 28 | 20.7 | 18.8 | 88 | 65.2 | 59.1 | 48 | 109.7 | 99.4 | 08 | 154.1 | 139.7 | 68 | 198.6 | 180.0 |
| 29 | 21.5 | 19.5 | 89 | 65.9 | 59.8 | 49 | 110.4 | 100.1 | 09 | 154.9 | 140.4 | 69 | 199.3 | 180.6 |
| 30 | 22.2 | 20.1 | 90 | 66.7 | 60.4 | 50 | 111.1 | 100.7 | 10 | 155.6 | 141.0 | 70 | 200.1 | 181.3 |
| 31 | 23.0 | 20.8 | 91 | 67.4 | 61.1 | 151 | 111.9 | 101.4 | 211 | 156.3 | 141.7 | 271 | 200.8 | 182.0 |
| 32 | 23.7 | 21.5 | 92 | 68.2 | 61.8 | 52 | 112.6 | 102.1 | 12 | 157.1 | 142.4 | 72 | 201.5 | 182.7 |
| 33 | 24.5 | 22.2 | 93 | 68.9 | 62.5 | 53 | 113.4 | 102.7 | 13 | 157.8 | 143.0 | 73 | 202.3 | 183.3 |
| 34 | 25.2 | 22.8 | 94 | 69.6 | 63.1 | 54 | 114.1 | 103.4 | 14 | 158.6 | 143.7 | 74 | 203.0 | 184.0 |
| 35 | 25.9 | 23.5 | 95 | 70.4 | 63.8 | 55 | 114.8 | 104.1 | 15 | 159.3 | 144.4 | 75 | 203.8 | 184.7 |
| 36 | 26.7 | 24.2 | 96 | 71.1 | 64.5 | 56 | 115.6 | 104.8 | 16 | 160.0 | 145.1 | 76 | 204.5 | 185.4 |
| 37 | 27.4 | 24.8 | 97 | 71.9 | 65.1 | 57 | 116.3 | 105.4 | 17 | 160.8 | 145.7 | 77 | 205.2 | 186.0 |
| 38 | 28.2 | 25.5 | 98 | 72.6 | 65.8 | 58 | 117.1 | 106.1 | 18 | 161.5 | 146.4 | 78 | 206.0 | 186.7 |
| 39 | 28.9 | 26.2 | 99 | 73.4 | 66.5 | 59 | 117.8 | 106.8 | 19 | 162.3 | 147.1 | 79 | 206.7 | 187.4 |
| 40 | 29.6 | 26.9 | 100 | 74.1 | 67.2 | 60 | 118.6 | 107.4 | 20 | 163.0 | 147.7 | 80 | 207.5 | 188.0 |
| 41 | 30.4 | 27.5 | 101 | 74.8 | 67.8 | 161 | 119.3 | 108.1 | 221 | 163.8 | 148.4 | 281 | 208.2 | 188.7 |
| 42 | 31.1 | 28.2 | 02 | 75.6 | 68.5 | 62 | 120.0 | 108.8 | 22 | 164.5 | 149.1 | 82 | 208.9 | 189.4 |
| 43 | 31.9 | 28.9 | 03 | 76.3 | 69.2 | 63 | 120.8 | 109.5 | 23 | 165.2 | 149.8 | 83 | 209.7 | 190.1 |
| 44 | 32.6 | 29.5 | 04 | 77.1 | 69.8 | 64 | 121.5 | 110.1 | 24 | 166.0 | 150.4 | 84 | 210.4 | 190.7 |
| 45 | 33.3 | 30.2 | 05 | 77.8 | 70.5 | 65 | 122.3 | 110.8 | 25 | 166.7 | 151.1 | 85 | 211.2 | 191.4 |
| 46 | 34.1 | 30.9 | 06 | 78.5 | 71.2 | 66 | 123.0 | 111.5 | 26 | 167.5 | 151.8 | 86 | 211.9 | 192.1 |
| 47 | 34.8 | 31.6 | 07 | 79.3 | 71.9 | 67 | 123.7 | 112.2 | 27 | 168.2 | 152.4 | 87 | 212.7 | 192.7 |
| 48 | 35.6 | 32.2 | 08 | 80.0 | 72.5 | 68 | 124.5 | 112.8 | 28 | 168.9 | 153.1 | 88 | 213.4 | 193.4 |
| 49 | 36.3 | 32.9 | 09 | 80.8 | 73.2 | 69 | 125.2 | 113.5 | 29 | 169.7 | 153.8 | 89 | 214.1 | 194.1 |
| 50 | 37.0 | 33.6 | 10 | 81.5 | 73.9 | 70 | 126.0 | 114.2 | 30 | 170.4 | 154.5 | 90 | 214.9 | 194.8 |
| 51 | 37.8 | 34.2 | 111 | 82.2 | 74.5 | 171 | 126.7 | 114.8 | 231 | 171.2 | 155.1 | 291 | 215.6 | 195.4 |
| 52 | 38.5 | 34.9 | 12 | 83.0 | 75.2 | 72 | 127.4 | 115.5 | 32 | 171.9 | 155.8 | 92 | 216.4 | 196.1 |
| 53 | 39.3 | 35.6 | 13 | 83.7 | 75.9 | 73 | 128.2 | 116.2 | 33 | 172.6 | 156.5 | 93 | 217.1 | 196.8 |
| 54 | 40.0 | 36.3 | 14 | 84.5 | 76.6 | 74 | 128.9 | 116.9 | 34 | 173.4 | 157.1 | 94 | 217.8 | 197.4 |
| 55 | 40.8 | 36.9 | 15 | 85.2 | 77.2 | 75 | 129.7 | 117.5 | 35 | 174.1 | 157.8 | 95 | 218.6 | 198.1 |
| 56 | 41.5 | 37.6 | 16 | 86.0 | 77.9 | 76 | 130.4 | 118.2 | 36 | 174.9 | 158.5 | 96 | 219.3 | 198.8 |
| 57 | 42.2 | 38.3 | 17 | 86.7 | 78.6 | 77 | 131.1 | 118.9 | 37 | 175.6 | 159.2 | 97 | 220.1 | 199.5 |
| 58 | 43.0 | 39.0 | 18 | 87.4 | 79.2 | 78 | 131.9 | 119.5 | 38 | 176.3 | 159.8 | 98 | 220.8 | 200.1 |
| 59 | 43.7 | 39.6 | 19 | 88.2 | 79.9 | 79 | 132.6 | 120.2 | 39 | 177.1 | 160.5 | 99 | 221.5 | 200.8 |
| 60 | 44.5 | 40.3 | 20 | 88.9 | 80.6 | 80 | 133.4 | 120.9 | 40 | 177.8 | 161.2 | 300 | 222.3 | 201.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| | NE. ¼ E. | | | SE. ¼ E. | | | NW. ¼ W. | | | SW. ¼ W. | | | [For 4¼ Points. |

## TABLE 1. [Page 367

Difference of Latitude and Departure for 4 Points.

| | NE. | | | NW. | | | SE. | | | SW. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
| 1 | 0.7 | 0.7 | 61 | 43.1 | 43.1 | 121 | 85.6 | 85.6 | 181 | 128.0 | 128.0 | 241 | 170.4 | 170.4 |
| 2 | 1.4 | 1.4 | 62 | 43.8 | 43.8 | 22 | 86.3 | 86.3 | 82 | 128.7 | 128.7 | 42 | 171.1 | 171.1 |
| 3 | 2.1 | 2.1 | 63 | 44.5 | 44.5 | 23 | 87.0 | 87.0 | 83 | 129.4 | 129.4 | 43 | 171.8 | 171.8 |
| 4 | 2.8 | 2.8 | 64 | 45.3 | 45.3 | 24 | 87.7 | 87.7 | 84 | 130.1 | 130.1 | 44 | 172.5 | 172.5 |
| 5 | 3.5 | 3.5 | 65 | 46.0 | 46.0 | 25 | 88.4 | 88.4 | 85 | 130.8 | 130.8 | 45 | 173.2 | 173.2 |
| 6 | 4.2 | 4.2 | 66 | 46.7 | 46.7 | 26 | 89.1 | 89.1 | 86 | 131.5 | 131.5 | 46 | 173.9 | 173.9 |
| 7 | 4.9 | 4.9 | 67 | 47.4 | 47.4 | 27 | 89.8 | 89.8 | 87 | 132.2 | 132.2 | 47 | 174.7 | 174.7 |
| 8 | 5.7 | 5.7 | 68 | 48.1 | 48.1 | 28 | 90.5 | 90.5 | 88 | 132.9 | 132.9 | 48 | 175.4 | 175.4 |
| 9 | 6.4 | 6.4 | 69 | 48.8 | 48.8 | 29 | 91.2 | 91.2 | 89 | 133.6 | 133.6 | 49 | 176.1 | 176.1 |
| 10 | 7.1 | 7.1 | 70 | 49.5 | 49.5 | 30 | 91.9 | 91.9 | 90 | 134.4 | 134.4 | 50 | 176.8 | 176.8 |
| 11 | 7.8 | 7.8 | 71 | 50.2 | 50.2 | 131 | 92.6 | 92.6 | 191 | 135.1 | 135.1 | 251 | 177.5 | 177.5 |
| 12 | ·8.5 | 8.5 | 72 | 50.9 | 50.9 | 32 | 93.3 | 93.3 | 92 | 135.8 | 135.8 | 52 | 178.2 | 178.2 |
| 13 | 9.2 | 9.2 | 73 | 51.6 | 51.6 | 33 | 94.0 | 94.0 | 93 | 136.5 | 136.5 | 53 | 178.9 | 178.9 |
| 14 | 9.9 | 9.9 | 74 | 52.3 | 52.3 | 34 | 94.8 | 94.8 | 94 | 137.2 | 137.2 | 54 | 179.6 | 179.6 |
| 15 | 10.6 | 10.6 | 75 | 53.0 | 53.0 | 35 | 95.5 | 95.5 | 95 | 137.9 | 137.9 | 55 | 180.3 | 180.3 |
| 16 | 11.3 | 11.3 | 76 | 53.7 | 53.7 | 36 | 96.2 | 96.2 | 96 | 138.6 | 138.6 | 56 | 181.0 | 181.0 |
| 17 | 12.0 | 12.0 | 77 | 54.4 | 54.4 | 37 | 96.9 | 96.9 | 97 | 139.3 | 139.3 | 57 | 181.7 | 181.7 |
| 18 | 12.7 | 12.7 | 78 | 55.2 | 55.2 | 38 | 97.6 | 97.6 | 98 | 140.0 | 140.0 | 58 | 182.4 | 182.4 |
| 19 | 13.4 | 13.4 | 79 | 55.9 | 55.9 | 39 | 98.3 | 98.3 | 99 | 140.7 | 140.7 | 59 | 183.1 | 183.1 |
| 20 | 14.1 | 14.1 | 80 | 56.6 | 56.6 | 40 | 99.0 | 99.0 | 200 | 141.4 | 141.4 | 60 | 183.8 | 183.8 |
| 21 | 14.8 | 14.8 | 81 | 57.3 | 57.3 | 141 | 99.7 | 99.7 | 201 | 142.1 | 142.1 | 261 | 184.6 | 184.6 |
| 22 | 15.6 | 15.6 | 82 | 58.0 | 58.0 | 42 | 100.4 | 100.4 | 02 | 142.8 | 142.8 | 62 | 185.3 | 185.3 |
| 23 | 16.3 | 16.3 | 83 | 58.7 | 58.7 | 43 | 101.1 | 101.1 | 03 | 143.5 | 143.5 | 63 | 186.0 | 186.0 |
| 24 | 17.0 | 17.0 | 84 | 59.4 | 59.4 | 44 | 101.8 | 101.8 | 04 | 144.2 | 144.2 | 64 | 186.7 | 186.7 |
| 25 | 17.7 | 17.7 | 85 | 60.1 | 60.1 | 45 | 102.5 | 102.5 | 05 | 145.0 | 145.0 | 65 | 187.4 | 187.4 |
| 26 | 18.4 | 18.4 | 86 | 60.8 | 60.8 | 46 | 103.2 | 103.2 | 06 | 145.7 | 145.7 | 66 | 188.1 | 188.1 |
| 27 | 19.1 | 19.1 | 87 | 61.5 | 61.5 | 47 | 103.9 | 103.9 | 07 | 146.4 | 146.4 | 67 | 188.8 | 188.8 |
| 28 | 19.8 | 19.8 | 88 | 62.2 | 62.2 | 48 | 104.7 | 104.7 | 08 | 147.1 | 147.1 | 68 | 189.5 | 189.5 |
| 29 | 20.5 | 20.5 | 89 | 62.9 | 62.9 | 49 | 105.4 | 105.4 | 09 | 147.8 | 147.8 | 69 | 190.2 | 190.2 |
| 30 | 21.2 | 21.2 | 90 | 63.6 | 63.6 | 50 | 106.1 | 106.1 | 10 | 148.5 | 148.5 | 70 | 190.9 | 190.9 |
| 31 | 21.9 | 21.9 | 91 | 64.3 | 64.3 | 151 | 106.8 | 106.8 | 211 | 149.2 | 149.2 | 271 | 191.6 | 191.6 |
| 32 | 22.6 | 22.6 | 92 | 65.1 | 65.1 | 52 | 107.5 | 107.5 | 12 | 149.9 | 149.9 | 72 | 192.3 | 192.3 |
| 33 | 23.3 | 23.3 | 93 | 65.8 | 65.8 | 53 | 108.2 | 108.2 | 13 | 150.6 | 150.6 | 73 | 193.0 | 193.0 |
| 34 | 24.0 | 24.0 | 94 | 66.5 | 66.5 | 54 | 108.9 | 108.9 | 14 | 151.3 | 151.3 | 74 | 193.7 | 193.7 |
| 35 | 24.7 | 24.7 | 95 | 67.2 | 67.2 | 55 | 109.6 | 109.6 | 15 | 152.0 | 152.0 | 75 | 194.5 | 194.5 |
| 36 | 25.5 | 25.5 | 96 | 67.9 | 67.9 | 56 | 110.3 | 110.3 | 16 | 152.7 | 152.7 | 76 | 195.2 | 195.2 |
| 37 | 26.2 | 26.2 | 97 | 68.6 | 68.6 | 57 | 111.0 | 111.0 | 17 | 153.4 | 153.4 | 77 | 195.9 | 195.9 |
| 38 | 26.9 | 26.9 | 98 | 69.3 | 69.3 | 58 | 111.7 | 111.7 | 18 | 154.1 | 154.1 | 78 | 196.6 | 196.6 |
| 39 | 27.6 | 27.6 | 99 | 70.0 | 70.0 | 59 | 112.4 | 112.4 | 19 | 154.9 | 154.9 | 79 | 197.3 | 197.3 |
| 40 | 28.3 | 28.3 | 100 | 70.7 | 70.7 | 60 | 113.1 | 113.1 | 20 | 155.6 | 155.6 | 80 | 198.0 | 198.0 |
| 41 | 29.0 | 29.0 | 101 | 71.4 | 71.4 | 161 | 113.8 | 113.8 | 221 | 156.3 | 156.3 | 281 | 198.7 | 198.7 |
| 42 | 29.7 | 29.7 | 02 | 72.1 | 72.1 | 62 | 114.6 | 114.6 | 22 | 157.0 | 157.0 | 82 | 199.4 | 199.4 |
| 43 | 30.4 | 30.4 | 03 | 72.8 | 72.8 | 63 | 115.3 | 115.3 | 23 | 157.7 | 157.7 | 83 | 200.1 | 200.1 |
| 44 | 31.1 | 31.1 | 04 | 73.5 | 73.5 | 64 | 116.0 | 116.0 | 24 | 158.4 | 158.4 | 84 | 200.8 | 200.8 |
| 45 | 31.8 | 31.8 | 05 | 74.2 | 74.2 | 65 | 116.7 | 116.7 | 25 | 159.1 | 159.1 | 85 | 201.5 | 201.5 |
| 46 | 32.5 | 32.5 | 06 | 75.0 | 75.0 | 66 | 117.4 | 117.4 | 26 | 159.8 | 159.8 | 86 | 202.2 | 202.2 |
| 47 | 33.2 | 33.2 | 07 | 75.7 | 75.7 | 67 | 118.1 | 118.1 | 27 | 160.5 | 160.5 | 87 | 202.9 | 202.9 |
| 48 | 33.9 | 33.9 | 08 | 76.4 | 76.4 | 68 | 118.8 | 118.8 | 28 | 161.2 | 161.2 | 88 | 203.6 | 203.6 |
| 49 | 34.6 | 34.6 | 09 | 77.1 | 77.1 | 69 | 119.5 | 119.5 | 29 | 161.9 | 161.9 | 89 | 204.4 | 204.4 |
| 50 | 35.4 | 35.4 | 10 | 77.8 | 77.8 | 70 | 120.2 | 120.2 | 30 | 162.6 | 162.6 | 90 | 205.1 | 205.1 |
| 51 | 36.1 | 36.1 | 111 | 78.5 | 78.5 | 171 | 120.9 | 120.9 | 231 | 163.3 | 163.3 | 291 | 205.8 | 205.8 |
| 52 | 36.8 | 36.8 | 12 | 79.2 | 79.2 | 72 | 121.6 | 121.6 | 32 | 164.0 | 164.0 | 92 | 206.5 | 206.5 |
| 53 | 37.5 | 37.5 | 13 | 79.9 | 79.9 | 73 | 122.3 | 122.3 | 33 | 164.8 | 164.8 | 93 | 207.2 | 207.2 |
| 54 | 38.2 | 38.2 | 14 | 80.6 | 80.6 | 74 | 123.0 | 123.0 | 34 | 165.5 | 165.5 | 94 | 207.9 | 207.9 |
| 55 | 38.9 | 38.9 | 15 | 81.3 | 81.3 | 75 | 123.7 | 123.7 | 35 | 166.2 | 166.2 | 95 | 208.6 | 208.6 |
| 56 | 39.6 | 39.6 | 16 | 82.0 | 82.0 | 76 | 124.5 | 124.5 | 36 | 166.9 | 166.9 | 96 | 209.3 | 209.3 |
| 57 | 40.3 | 40.3 | 17 | 82.7 | 82.7 | 77 | 125.2 | 125.2 | 37 | 167.6 | 167.6 | 97 | 210.0 | 210.0 |
| 58 | 41.0 | 41.0 | 18 | 83.4 | 83.4 | 78 | 125.9 | 125.9 | 38 | 168.3 | 168.3 | 98 | 210.7 | 210.7 |
| 59 | 41.7 | 41.7 | 19 | 84.1 | 84.1 | 79 | 126.6 | 126.6 | 39 | 169.0 | 169.0 | 99 | 211.4 | 211.4 |
| 60 | 42.4 | 42.4 | 20 | 84.9 | 84.9 | 80 | 127.3 | 127.3 | 40 | 169.7 | 169.7 | 300 | 212.1 | 212.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

| NE. | NW. | SE. | SW. | [For 4 Points. |

# TABLE 2.

### Difference of Latitude and Departure for 1° (179°, 181°, 359°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.0 | 61 | 61.0 | 1.1 | 121 | 121.0 | 2.1 | 181 | 181.0 | 3.2 | 241 | 241.0 | 4.2 |
| 2 | 2.0 | 0.0 | 62 | 62.0 | 1.1 | 22 | 122.0 | 2.1 | 82 | 182.0 | 3.2 | 42 | 242.0 | 4.2 |
| 3 | 3.0 | 0.1 | 63 | 63.0 | 1.1 | 23 | 123.0 | 2.1 | 83 | 183.0 | 3.2 | 43 | 243.0 | 4.2 |
| 4 | 4.0 | 0.1 | 64 | 64.0 | 1.1 | 24 | 124.0 | 2.2 | 84 | 184.0 | 3.2 | 44 | 244.0 | 4.3 |
| 5 | 5.0 | 0.1 | 65 | 65.0 | 1.1 | 25 | 125.0 | 2.2 | 85 | 185.0 | 3.2 | 45 | 245.0 | 4.3 |
| 6 | 6.0 | 0.1 | 66 | 66.0 | 1.2 | 26 | 126.0 | 2.2 | 86 | 186.0 | 3.2 | 46 | 246.0 | 4.3 |
| 7 | 7.0 | 0.1 | 67 | 67.0 | 1.2 | 27 | 127.0 | 2.2 | 87 | 187.0 | 3.3 | 47 | 247.0 | 4.3 |
| 8 | 8.0 | 0.1 | 68 | 68.0 | 1.2 | 28 | 128.0 | 2.2 | 88 | 188.0 | 3.3 | 48 | 248.0 | 4.3 |
| 9 | 9.0 | 0.2 | 69 | 69.0 | 1.2 | 29 | 129.0 | 2.3 | 89 | 189.0 | 3.3 | 49 | 249.0 | 4.3 |
| 10 | 10.0 | 0.2 | 70 | 70.0 | 1.2 | 30 | 130.0 | 2.3 | 90 | 190.0 | 3.3 | 50 | 250.0 | 4.4 |
| 11 | 11.0 | 0.2 | 71 | 71.0 | 1.2 | 131 | 131.0 | 2.3 | 191 | 191.0 | 3.3 | 251 | 251.0 | 4.4 |
| 12 | 12.0 | 0.2 | 72 | 72.0 | 1.3 | 32 | 132.0 | 2.3 | 92 | 192.0 | 3.4 | 52 | 252.0 | 4.4 |
| 13 | 13.0 | 0.2 | 73 | 73.0 | 1.3 | 33 | 133.0 | 2.3 | 93 | 193.0 | 3.4 | 53 | 253.0 | 4.4 |
| 14 | 14.0 | 0.2 | 74 | 74.0 | 1.3 | 34 | 134.0 | 2.3 | 94 | 194.0 | 3.4 | 54 | 254.0 | 4.4 |
| 15 | 15.0 | 0.3 | 75 | 75.0 | 1.3 | 35 | 135.0 | 2.4 | 95 | 195.0 | 3.4 | 55 | 255.0 | 4.5 |
| 16 | 16.0 | 0.3 | 76 | 76.0 | 1.3 | 36 | 136.0 | 2.4 | 96 | 196.0 | 3.4 | 56 | 256.0 | 4.5 |
| 17 | 17.0 | 0.3 | 77 | 77.0 | 1.3 | 37 | 137.0 | 2.4 | 97 | 197.0 | 3.4 | 57 | 257.0 | 4.5 |
| 18 | 18.0 | 0.3 | 78 | 78.0 | 1.4 | 38 | 138.0 | 2.4 | 98 | 198.0 | 3.5 | 58 | 258.0 | 4.5 |
| 19 | 19.0 | 0.3 | 79 | 79.0 | 1.4 | 39 | 139.0 | 2.4 | 99 | 199.0 | 3.5 | 59 | 259.0 | 4.5 |
| 20 | 20.0 | 0.3 | 80 | 80.0 | 1.4 | 40 | 140.0 | 2.4 | 200 | 200.0 | 3.5 | 60 | 260.0 | 4.5 |
| 21 | 21.0 | 0.4 | 81 | 81.0 | 1.4 | 141 | 141.0 | 2.5 | 201 | 201.0 | 3.5 | 261 | 261.0 | 4.6 |
| 22 | 22.0 | 0.4 | 82 | 82.0 | 1.4 | 42 | 142.0 | 2.5 | 02 | 202.0 | 3.5 | 62 | 262.0 | 4.6 |
| 23 | 23.0 | 0.4 | 83 | 83.0 | 1.4 | 43 | 143.0 | 2.5 | 03 | 203.0 | 3.5 | 63 | 263.0 | 4.6 |
| 24 | 24.0 | 0.4 | 84 | 84.0 | 1.5 | 44 | 144.0 | 2.5 | 04 | 204.0 | 3.6 | 64 | 264.0 | 4.6 |
| 25 | 25.0 | 0.4 | 85 | 85.0 | 1.5 | 45 | 145.0 | 2.5 | 05 | 205.0 | 3.6 | 65 | 265.0 | 4.6 |
| 26 | 26.0 | 0.5 | 86 | 86.0 | 1.5 | 46 | 146.0 | 2.5 | 06 | 206.0 | 3.6 | 66 | 266.0 | 4.6 |
| 27 | 27.0 | 0.5 | 87 | 87.0 | 1.5 | 47 | 147.0 | 2.6 | 07 | 207.0 | 3.6 | 67 | 267.0 | 4.7 |
| 28 | 28.0 | 0.5 | 88 | 88.0 | 1.5 | 48 | 148.0 | 2.6 | 08 | 208.0 | 3.6 | 68 | 268.0 | 4.7 |
| 29 | 29.0 | 0.5 | 89 | 89.0 | 1.6 | 49 | 149.0 | 2.6 | 09 | 209.0 | 3.6 | 69 | 269.0 | 4.7 |
| 30 | 30.0 | 0.5 | 90 | 90.0 | 1.6 | 50 | 150.0 | 2.6 | 10 | 210.0 | 3.7 | 70 | 270.0 | 4.7 |
| 31 | 31.0 | 0.5 | 91 | 91.0 | 1.6 | 151 | 151.0 | 2.6 | 211 | 211.0 | 3.7 | 271 | 271.0 | 4.7 |
| 32 | 32.0 | 0.6 | 92 | 92.0 | 1.6 | 52 | 152.0 | 2.7 | 12 | 212.0 | 3.7 | 72 | 272.0 | 4.7 |
| 33 | 33.0 | 0.6 | 93 | 93.0 | 1.6 | 53 | 153.0 | 2.7 | 13 | 213.0 | 3.7 | 73 | 273.0 | 4.8 |
| 34 | 34.0 | 0.6 | 94 | 94.0 | 1.6 | 54 | 154.0 | 2.7 | 14 | 214.0 | 3.7 | 74 | 274.0 | 4.8 |
| 35 | 35.0 | 0.6 | 95 | 95.0 | 1.7 | 55 | 155.0 | 2.7 | 15 | 215.0 | 3.8 | 75 | 275.0 | 4.8 |
| 36 | 36.0 | 0.6 | 96 | 96.0 | 1.7 | 56 | 156.0 | 2.7 | 16 | 216.0 | 3.8 | 76 | 276.0 | 4.8 |
| 37 | 37.0 | 0.6 | 97 | 97.0 | 1.7 | 57 | 157.0 | 2.7 | 17 | 217.0 | 3.8 | 77 | 277.0 | 4.8 |
| 38 | 38.0 | 0.7 | 98 | 98.0 | 1.7 | 58 | 158.0 | 2.8 | 18 | 218.0 | 3.8 | 78 | 278.0 | 4.9 |
| 39 | 39.0 | 0.7 | 99 | 99.0 | 1.7 | 59 | 159.0 | 2.8 | 19 | 219.0 | 3.8 | 79 | 279.0 | 4.9 |
| 40 | 40.0 | 0.7 | 100 | 100.0 | 1.7 | 60 | 160.0 | 2.8 | 20 | 220.0 | 3.8 | 80 | 280.0 | 4.9 |
| 41 | 41.0 | 0.7 | 101 | 101.0 | 1.8 | 161 | 161.0 | 2.8 | 221 | 221.0 | 3.9 | 281 | 281.0 | 4.9 |
| 42 | 42.0 | 0.7 | 02 | 102.0 | 1.8 | 62 | 162.0 | 2.8 | 22 | 222.0 | 3.9 | 82 | 282.0 | 4.9 |
| 43 | 43.0 | 0.8 | 03 | 103.0 | 1.8 | 63 | 163.0 | 2.8 | 23 | 223.0 | 3.9 | 83 | 283.0 | 4.9 |
| 44 | 44.0 | 0.8 | 04 | 104.0 | 1.8 | 64 | 164.0 | 2.9 | 24 | 224.0 | 3.9 | 84 | 284.0 | 5.0 |
| 45 | 45.0 | 0.8 | 05 | 105.0 | 1.8 | 65 | 165.0 | 2.9 | 25 | 225.0 | 3.9 | 85 | 285.0 | 5.0 |
| 46 | 46.0 | 0.8 | 06 | 106.0 | 1.8 | 66 | 166.0 | 2.9 | 26 | 226.0 | 3.9 | 86 | 286.0 | 5.0 |
| 47 | 47.0 | 0.8 | 07 | 107.0 | 1.9 | 67 | 167.0 | 2.9 | 27 | 227.0 | 4.0 | 87 | 287.0 | 5.0 |
| 48 | 48.0 | 0.8 | 08 | 108.0 | 1.9 | 68 | 168.0 | 2.9 | 28 | 228.0 | 4.0 | 88 | 288.0 | 5.0 |
| 49 | 49.0 | 0.9 | 09 | 109.0 | 1.9 | 69 | 169.0 | 2.9 | 29 | 229.0 | 4.0 | 89 | 289.0 | 5.0 |
| 50 | 50.0 | 0.9 | 10 | 110.0 | 1.9 | 70 | 170.0 | 3.0 | 30 | 230.0 | 4.0 | 90 | 290.0 | 5.1 |
| 51 | 51.0 | 0.9 | 111 | 111.0 | 1.9 | 171 | 171.0 | 3.0 | 231 | 231.0 | 4.0 | 291 | 291.0 | 5.1 |
| 52 | 52.0 | 0.9 | 12 | 112.0 | 2.0 | 72 | 172.0 | 3.0 | 32 | 232.0 | 4.0 | 92 | 292.0 | 5.1 |
| 53 | 53.0 | 0.9 | 13 | 113.0 | 2.0 | 73 | 173.0 | 3.0 | 33 | 233.0 | 4.1 | 93 | 293.0 | 5.1 |
| 54 | 54.0 | 0.9 | 14 | 114.0 | 2.0 | 74 | 174.0 | 3.0 | 34 | 234.0 | 4.1 | 94 | 294.0 | 5.1 |
| 55 | 55.0 | 1.0 | 15 | 115.0 | 2.0 | 75 | 175.0 | 3.1 | 35 | 235.0 | 4.1 | 95 | 295.0 | 5.1 |
| 56 | 56.0 | 1.0 | 16 | 116.0 | 2.0 | 76 | 176.0 | 3.1 | 36 | 236.0 | 4.1 | 96 | 296.0 | 5.2 |
| 57 | 57.0 | 1.0 | 17 | 117.0 | 2.0 | 77 | 177.0 | 3.1 | 37 | 237.0 | 4.1 | 97 | 297.0 | 5.2 |
| 58 | 58.0 | 1.0 | 18 | 118.0 | 2.1 | 78 | 178.0 | 3.1 | 38 | 238.0 | 4.2 | 98 | 298.0 | 5.2 |
| 59 | 59.0 | 1.0 | 19 | 119.0 | 2.1 | 79 | 179.0 | 3.1 | 39 | 239.0 | 4.2 | 99 | 299.0 | 5.2 |
| 60 | 60.0 | 1.0 | 20 | 120.0 | 2.1 | 80 | 180.0 | 3.1 | 40 | 240.0 | 4.2 | 300 | 300.0 | 5.2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

89° (91°, 269°, 271°).

# TABLE 2.

Difference of Latitude and Departure for 1° (179°, 181°, 359°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 301.0 | 5.3 | 361 | 360.9 | 6.3 | 421 | 420.9 | 7.3 | 481 | 480.9 | 8.4 | 541 | 540.9 | 9.5 |
| 02 | 302.0 | 5.3 | 62 | 361.9 | 6.3 | 22 | 421.9 | 7.4 | 82 | 481.9 | 8.4 | 42 | 541.9 | 9.5 |
| 03 | 303.0 | 5.3 | 63 | 362.9 | 6.3 | 23 | 422.9 | 7.4 | 83 | 482.9 | 8.5 | 43 | 542.9 | 9.5 |
| 04 | 304.0 | 5.3 | 64 | 363.9 | 6.4 | 24 | 423.9 | 7.4 | 84 | 483.9 | 8.5 | 44 | 543.9 | 9.5 |
| 05 | 305.0 | 5.3 | 65 | 364.9 | 6.4 | 25 | 424.9 | 7.4 | 85 | 484.9 | 8.5 | 45 | 544.9 | 9.5 |
| 06 | 306.0 | 5.3 | 66 | 365.9 | 6.4 | 26 | 425.9 | 7.4 | 86 | 485.9 | 8.5 | 46 | 545.9 | 9.5 |
| 07 | 307.0 | 5.4 | 67 | 366.9 | 6.4 | 27 | 426.9 | 7.4 | 87 | 486.9 | 8.5 | 47 | 546.9 | 9.6 |
| 08 | 308.0 | 5.4 | 68 | 367.9 | 6.4 | 28 | 427.9 | 7.5 | 88 | 487.9 | 8.6 | 48 | 547.9 | 9.6 |
| 09 | 309.0 | 5.4 | 69 | 368.9 | 6.4 | 29 | 428.9 | 7.5 | 89 | 488.9 | 8.6 | 49 | 548.9 | 9.6 |
| 10 | 310.0 | 5.4 | 70 | 369.9 | 6.5 | 30 | 429.9 | 7.5 | 90 | 489.9 | 8.6 | 50 | 549.9 | 9.6 |
| 311 | 311.0 | 5.4 | 371 | 370.9 | 6.5 | 431 | 430.9 | 7.5 | 491 | 490.9 | 8.6 | 551 | 550.9 | 9.6 |
| 12 | 312.0 | 5.4 | 72 | 371.9 | 6.5 | 32 | 431.9 | 7.5 | 92· | 491.9 | 8.6 | 52 | 551.9 | 9.6 |
| 13 | 313.0 | 5.5 | 73 | 372.9 | 6.5 | 33 | 432.9 | 7.5 | 93 | 492.9 | 8.7 | 53 | 552.9 | 9.7 |
| 14 | 314.0 | 5.5 | 74 | 373.9 | 6.5 | 34 | 433.9 | 7.6 | 94 | 493.9 | 8.7 | 54 | 553.9 | 9.7 |
| 15 | 315.0 | 5.5 | 75 | 374.9 | 6.5 | 35 | 434.9 | 7.6 | 95 | 494.9 | 8.7 | 55 | 554.9 | 9.7 |
| 16 | 316.0 | 5.5 | 76 | 375.9 | 6.6 | 36 | 435.9 | 7.6 | 96 | 495.9 | 8.7 | 56 | 555.9 | 9.7 |
| 17 | 317.0 | 5.5 | 77 | 376.9 | 6.6 | 37 | 436.9 | 7.6 | 97 | 496.9 | 8.7 | 57 | 556.9 | 9.7 |
| 18 | 318.0 | 5.5 | 78 | 377.9 | 6.6 | 38 | 437.9 | 7.6 | 98 | 497.9 | 8.7 | 58 | 557.9 | 9.7 |
| 19 | 319.0 | 5.6 | 79 | 378.9 | 6.6 | 39 | 438.9 | 7.7 | 99 | 498.9 | 8.8 | 59 | 558.9 | 9.8 |
| 20 | 320.0 | 5.6 | 80 | 379.9 | 6.6 | 40 | 439.9 | 7.7 | 500 | 499.9 | 8.8 | 60 | 559.9 | 9.8 |
| 321 | 321.0 | 5.6 | 381 | 380.9 | 6.7 | 441 | 440.9 | 7.7 | 501 | 500.9 | 8.8 | 561 | 560.9 | 9.8 |
| 22 | 322.0 | 5.6 | 82 | 381.9 | 6.7 | 42 | 441.9 | 7.7 | 02 | 501.9 | 8.8 | 62 | 561.9 | 9.8 |
| 23 | 323.0 | 5.6 | 83 | 382.9 | 6.7 | 43 | 442.9 | 7.7 | 03 | 502.9 | 8.8 | 63 | 562.9 | 9.8 |
| 24 | 324.0 | 5.6 | 84 | 383.9 | 6.7 | 44 | 443.9 | 7.7 | 04 | 503.9 | 8.8 | 64 | 563.9 | 9.8 |
| 25 | 325.0 | 5.7 | 85 | 384.9 | 6.7 | 45 | 444.9 | 7.8 | 05 | 504.9 | 8.8 | 65 | 564.9 | 9.9 |
| 26 | 326.0 | 5.7 | 86 | 385.9 | 6.7 | 46 | 445.9 | 7.8 | 06 | 505.9 | 8.9 | 66 | 565.9 | 9.9 |
| 27 | 327.0 | 5.7 | 87 | 386.9 | 6.8 | 47 | 446.9 | 7.8 | 07 | 506.9 | 8.9 | 67 | 566.9 | 9.9 |
| 28 | 328.0 | 5.7 | 88 | 387.9 | 6.8 | 48 | 447.9 | 7.8 | 08 | 507.9 | 8.9 | 68 | 567.9 | 9.9 |
| 29 | 329.0 | 5.7 | 89 | 388.9 | 6.8 | 49 | 448.9 | 7.8 | 09 | 508.9 | 8.9 | 69 | 568.9 | 9.9 |
| 30 | 330.0 | 5.8 | 90 | 389.9 | 6.8 | 50 | 449.9 | 7.8 | 10 | 509.9 | 8.9 | 70 | 569.9 | 9.9 |
| 331 | 331.0 | 5.8 | 391 | 390.9 | 6.8 | 451 | 450.9 | 7.9 | 511 | 510.9 | 9.0 | 571 | 570.9 | 10.0 |
| 32 | 332.0 | 5.8 | 92 | 391.9 | 6.8 | 52 | 451.9 | 7.9 | 12 | 511.9 | 9.0 | 72 | 571.9 | 10.0 |
| 33 | 333.0 | 5.8 | 93 | 392.9 | 6.9 | 53 | 452.9 | 7.9 | 13 | 512.9 | 9.0 | 73 | 572.9 | 10.0 |
| 34 | 333.9 | 5.8 | 94 | 393.9 | 6.9 | 54 | 453.9 | 7.9 | 14 | 513.9 | 9.0 | 74 | 573.9 | 10.0 |
| 35 | 334.9 | 5.8 | 95 | 394.9 | 6.9 | 55 | 454.9 | 7.9 | 15 | 514.9 | 9.0 | 75 | 574.9 | 10.0 |
| 36 | 335.9 | 5.9 | 96 | 395.9 | 6.9 | 56 | 455.9 | 8.0 | 16 | 515.9 | 9.0 | 76 | 575.9 | 10.0 |
| 37 | 336.9 | 5.9 | 97 | 396.9 | 6.9 | 57 | 456.9 | 8.0 | 17 | 516.9 | 9.1 | 77 | 576.9 | 10.1 |
| 38 | 337.9 | 5.9 | 98 | 397.9 | 6.9 | 58 | 457.9 | 8.0 | 18 | 517.9 | 9.1 | 78 | 577.9 | 10.1 |
| 39 | 338.9 | 5.9 | 99 | 398.9 | 7.0 | 59 | 458.9 | 8.0 | 19 | 518.9 | 9.1 | 79 | 578.9 | 10.1 |
| 40 | 339.9 | 5.9 | 400 | 399.9 | 7.0 | 60 | 459.9 | 8.0 | 20 | 519.9 | 9.1 | 80 | 579.9 | 10.1 |
| 341 | 340.9 | 6.0 | 401 | 400.9 | 7.0 | 461 | 460.9 | 8.0 | 521 | 520.9 | 9.1 | 581 | 580.9 | 10.1 |
| 42 | 341.9 | 6.0 | 02 | 401.9 | 7.0 | 62 | 461.9 | 8.1 | 22 | 521.9 | 9.1 | 82 | 581.9 | 10.1 |
| 43 | 342.9 | 6.0 | 03 | 402.9 | 7.0 | 63 | 462.9 | 8.1 | 23 | 522.9 | 9.2 | 83 | 582.9 | 10.2 |
| 44 | 343.9 | 6.0 | 04 | 403.9 | 7.1 | 64 | 463.9 | 8.1 | 24 | 523.9 | 9.2 | 84 | 583.9 | 10.2 |
| 45 | 344.9 | 6.0 | 05 | 404.9 | 7.1 | 65 | 464.9 | 8.1 | 25 | 524.9 | 9.2 | 85 | 584.9 | 10.2 |
| 46 | 345.9 | 6.0 | 06 | 405.9 | 7.1 | 66 | 465.9 | 8.1 | 26 | 525.9 | 9.2 | 86 | 585.9 | 10.2 |
| 47 | 346.9 | 6.1 | 07 | 406.9 | 7.1 | 67 | 466.9 | 8.1 | 27 | 526.9 | 9.2 | 87 | 586.9 | 10.2 |
| 48 | 347.9 | 6.1 | 08 | 407.9 | 7.1 | 68 | 467.9 | 8.2 | 28 | 527.9 | 9.2 | 88 | 587.9 | 10.2 |
| 49 | 348.9 | 6.1 | 09 | 408.9 | 7.1 | 69 | 468.9 | 8.2 | 29 | 528.9 | 9.3 | 89 | 588.9 | 10.3 |
| 50 | 349.9 | 6.1 | 10 | 409.9 | 7.2 | 70 | 469.9 | 8.2 | 30 | 529.9 | 9.3 | 90 | 589.9 | 10.3 |
| 351 | 350.9 | 6.1 | 411 | 410.9 | 7.2 | 471 | 470.9 | 8.2 | 531 | 530.9 | 9.3 | 591 | 590.9 | 10.3 |
| 52 | 351.9 | 6.1 | 12 | 411.9 | 7.2 | 72 | 471.9 | 8.2 | 32 | 531.9 | 9.3 | 92 | 591.9 | 10.3 |
| 53 | 352.9 | 6.2 | 13 | 412.9 | 7.2 | 73 | 472.9 | 8.2 | 33 | 532.9 | 9.3 | 93 | 592.9 | 10.3 |
| 54 | 353.9 | 6.2 | 14 | 413.9 | 7.2 | 74 | 473.9 | 8.3 | 34 | 533.9 | 9.3 | 94 | 593.9 | 10.3 |
| 55 | 354.9 | 6.2 | 15 | 414.9 | 7.2 | 75 | 474.9 | 8.3 | 35 | 534.9 | 9.4 | 95 | 594.9 | 10.4 |
| 56 | 355.9 | 6.2 | 16 | 415.9 | 7.3 | 76 | 475.9 | 8.3 | 36 | 535.9 | 9.4 | 96 | 595.9 | 10.4 |
| 57 | 356.9 | 6.2 | 17 | 416.9 | 7.3 | 77 | 476.9 | 8.3 | 37 | 536.9 | 9.4 | 97 | 596.9 | 10.4 |
| 58 | 357.9 | 6.2 | 18 | 417.9 | 7.3 | 78 | 477.9 | 8.3 | 38 | 537.9 | 9.4 | 98 | 597.9 | 10.4 |
| 59 | 358.9 | 6.3 | 19 | 418.9 | 7.3 | 79 | 478.9 | 8.4 | 39 | 538.9 | 9.4 | 99 | 598.9 | 10.4 |
| 60 | 359.9 | 6.3 | 20 | 419.9 | 7.3 | 80 | 479.9 | 8.4 | 40 | 539.9 | 9.4 | 600 | 599.9 | 10.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

89° (91°, 269°, 271°).

6583—06——24

# TABLE 2.

Difference of Latitude and Departure for 2° (178°, 182°, 358°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.0 | 61 | 61.0 | 2.1 | 121 | 120.9 | 4.2 | 181 | 180.9 | 6.3 | 241 | 240.9 | 8.4 |
| 2 | 2.0 | 0.1 | 62 | 62.0 | 2.2 | 22 | 121.9 | 4.3 | 82 | 181.9 | 6.4 | 42 | 241.9 | 8.4 |
| 3 | 3.0 | 0.1 | 63 | 63.0 | 2.2 | 23 | 122.9 | 4.3 | 83 | 182.9 | 6.4 | 43 | 242.9 | 8.5 |
| 4 | 4.0 | 0.1 | 64 | 64.0 | 2.2 | 24 | 123.9 | 4.3 | 84 | 183.9 | 6.4 | 44 | 243.9 | 8.5 |
| 5 | 5.0 | 0.2 | 65 | 65.0 | 2.3 | 25 | 124.9 | 4.4 | 85 | 184.9 | 6.5 | 45 | 244.9 | 8.6 |
| 6 | 6.0 | 0.2 | 66 | 66.0 | 2.3 | 26 | 125.9 | 4.4 | 86 | 185.9 | 6.5 | 46 | 245.9 | 8.6 |
| 7 | 7.0 | 0.2 | 67 | 67.0 | 2.3 | 27 | 126.9 | 4.4 | 87 | 186.9 | 6.5 | 47 | 246.8 | 8.6 |
| 8 | 8.0 | 0.3 | 68 | 68.0 | 2.4 | 28 | 127.9 | 4.5 | 88 | 187.9 | 6.6 | 48 | 247.8 | 8.7 |
| 9 | 9.0 | 0.3 | 69 | 69.0 | 2.4 | 29 | 128.9 | 4.5 | 89 | 188.9 | 6.6 | 49 | 248.8 | 8.7 |
| 10 | 10.0 | .0.3 | 70 | 70.0 | 2.4 | 30 | 129.9 | 4.5 | 90 | 189.9 | 6.6 | 50 | 249.8 | 8.7 |
| 11 | 11.0 | 0.4 | 71 | 71.0 | 2.5 | 131 | 130.9 | 4.6 | 191 | 190.9 | 6.7 | 251 | 250.8 | 8.8 |
| 12 | 12.0 | 0.4 | 72 | 72.0 | 2.5 | 32 | 131.9 | 4.6 | 92 | 191.9 | 6.7 | 52 | 251.8 | 8.8 |
| 13 | 13.0 | 0.5 | 73 | 73.0 | 2.5 | 33 | 132.9 | 4.6 | 93 | 192.9 | 6.7 | 53 | 252.8 | 8.8 |
| 14 | 14.0 | 0.5 | 74 | 74.0 | 2.6 | 34 | 133.9 | 4.7 | 94 | 193.9 | 6.8 | 54 | 253.8 | 8.9 |
| 15 | 15.0 | 0.5 | 75 | 75.0 | 2.6 | 35 | 134.9 | 4.7 | 95 | 194.9 | 6.8 | 55 | 254.8 | 8.9 |
| 16 | 16.0 | 0.6 | 76 | 76.0 | 2.7 | 36 | 135.9 | 4.7 | 96 | 195.9 | 6.8 | 56 | 255.8 | 8.9 |
| 17 | 17.0 | 0.6 | 77 | 77.0 | 2.7 | 37 | 136.9 | 4.8 | 97 | 196.9 | 6.9 | 57 | 256.8 | 9.0 |
| 18 | 18.0 | 0.6 | 78 | 78.0 | 2.7 | 38 | 137.9 | 4.8 | 98 | 197.9 | 6.9 | 58 | 257.8 | 9.0 |
| 19 | 19.0 | 0.7 | 79 | 79.0 | 2.8 | 39 | 138.9 | 4.9 | 99 | 198.9 | 6.9 | 59 | 258.8 | 9.0 |
| 20 | 20.0 | 0.7 | 80 | 80.0 | 2.8 | 40 | 139.9 | 4.9 | 200 | 199.9 | 7.0 | 60 | 259.8 | 9.1 |
| 21 | 21.0 | 0.7 | 81 | 81.0 | 2.8 | 141 | 140.9 | 4.9 | 201 | 200.9 | 7.0 | 261 | 260.8 | 9.1 |
| 22 | 22.0 | 0.8 | 82 | 82.0 | 2.9 | 42 | 141.9 | 5.0 | 02 | 201.9 | 7.0 | 62 | 261.8 | 9.1 |
| 23 | 23.0 | 0.8 | 83 | 82.9 | 2.9 | 43 | 142.9 | 5.0 | 03 | 202.9 | 7.1 | 63 | 262.8 | 9.2 |
| 24 | 24.0 | 0.8 | 84 | 83.9 | 2.9 | 44 | 143.9 | 5.0 | 04 | 203.9 | 7.1 | 64 | 263.8 | 9.2 |
| 25 | 25.0 | 0.9 | 85 | 84.9 | 3.0 | 45 | 144.9 | 5.1 | 05 | 204.9 | 7.2 | 65 | 264.8 | 9.2 |
| 26 | 26.0 | 0.9 | 86 | 85.9 | 3.0 | 46 | 145.9 | 5.1 | 06 | 205.9 | 7.2 | 66 | 265.8 | 9.3 |
| 27 | 27.0 | 0.9 | 87 | 86.9 | 3.0 | 47 | 146.9 | 5.1 | 07 | 206.9 | 7.2 | 67 | 266.8 | 9.3 |
| 28 | 28.0 | 1.0 | 88 | 87.9 | 3.1 | 48 | 147.9 | 5.2 | 08 | 207.9 | 7.3 | 68 | 267.8 | 9.4 |
| 29 | 29.0 | 1.0 | 89 | 88.9 | 3.1 | 49 | 148.9 | 5.2 | 09· | 208.9 | 7.3 | 69 | 268.8 | 9.4 |
| 30 | 30.0 | 1.0 | 90 | 89.9 | 3.1 | 50 | 149.9 | 5.2 | 10 | 209.9 | 7.3 | 70 | 269.8 | 9.4 |
| 31 | 31.0 | 1.1 | 91 | 90.9 | 3.2 | 151 | 150.9 | 5.3 | 211 | 210.9 | 7.4 | 271 | 270.8 | 9.5 |
| 32 | 32.0 | 1.1 | 92 | 91.9 | 3.2 | 52 | 151.9 | 5.3 | 12 | 211.9 | 7.4 | 72 | 271.8 | 9.5 |
| 33 | 33.0 | 1.2 | 93 | 92.9 | 3.2 | 53 | 152.9 | 5.3 | 13 | 212.9 | 7.4 | 73 | 272.8 | 9.5 |
| 34 | 34.0 | 1.2 | 94 | 93.9 | 3.3 | 54 | 153.9 | 5.4 | 14 | 213.9 | 7.5 | 74 | 273.8 | 9.6 |
| 35 | 35.0 | 1.2 | 95 | 94.9 | 3.3 | 55 | 154.9 | 5.4 | 15 | 214.9 | 7.5 | 75 | 274.8 | 9.6 |
| 36 | 36.0 | 1.3 | 96 | 95.9 | 3.4 | 56 | 155.9 | 5.4 | 16 | 215.9 | 7.5 | 76 | 275.8 | 9.6 |
| 37 | 37.0 | 1.3 | 97 | 96.9 | 3.4 | 57 | 156.9 | 5.5 | 17 | 216.9 | 7.6 | 77 | 276.8 | 9.7 |
| 38 | 38.0 | 1.3 | 98 | 97.9 | 3.4 | 58 | 157.9 | 5.5 | 18 | 217.9 | 7.6 | 78 | 277.8· | 9.7 |
| 39 | 39.0 | 1.4 | 99 | 98.9 | 3.5 | 59 | 158.9 | 5.5 | 19 | 218.9 | 7.6 | 79 | 278.8 | 9.7 |
| 40 | 40.0 | 1.4 | 100 | 99.9 | 3.5 | 60 | 159.9 | 5.6 | 20 | 219.9 | 7.7 | 80 | 279.8 | 9.8 |
| 41 | 41.0 | 1.4 | 101 | 100.9 | 3.5 | 161 | 160.9 | 5.6 | 221 | 220.9 | 7.7 | 281 | 280.8 | 9.8 |
| 42 | 42.0 | 1.5 | 02 | 101.9 | 3.6 | 62 | 161.9 | 5.7 | 22 | 221.9 | 7.7 | 82 | 281.8 | 9.8 |
| 43 | 43.0 | 1.5 | 03 | 102.9 | 3.6 | 63 | 162.9 | 5.7 | 23 | 222.9 | 7.8 | 83 | 282.8 | 9.9 |
| 44 | 44.0 | 1.5 | 04 | 103.9 | 3.6 | 64 | 163.9 | 5.7 | 24 | 223.9 | 7.8 | 84 | 283.8 | 9.9 |
| 45 | 45.0 | 1.6 | 05 | 104.9 | 3.7 | 65 | 164.9 | 5.8 | 25 | 224.9 | 7.9 | 85 | 284.8 | 9.9 |
| 46 | 46.0 | 1.6 | 06 | 105.9 | 3.7 | 66 | 165.9 | 5.8 | 26 | 225.9 | 7.9 | 86 | 285.8 | 10.0 |
| 47 | 47.0 | 1.6 | 07 | 106.9 | 3.7 | 67 | 166.9 | 5.8 | 27 | 226.9 | 7.9 | 87 | 286.8 | 10.0 |
| 48 | 48.0 | 1.7 | 08 | 107.9 | 3.8 | 68 | 167.9 | 5.9 | 28 | 227.9 | 8.0 | 88 | 287.8 | 10.1 |
| 49 | 49.0 | 1.7 | 09 | 108.9 | 3.8 | 69 | 168.9 | 5.9 | 29 | 228.9 | 8.0 | 89 | 288.8 | 10.1 |
| 50 | 50.0 | 1.7 | 10 | 109.9 | 3.8 | 70 | 169.9 | 5.9 | 30 | 229.9 | 8.0 | 90 | 289.8 | 10.1 |
| 51 | 51.0 | 1.8 | 111 | 110.9 | 3.9 | 171 | 170.9 | 6.0 | 231 | 230.9 | 8.1 | 291 | 290.8 | 10.2 |
| 52 | 52.0 | 1.8 | 12 | 111.9 | 3.9 | 72 | 171.9 | 6.0 | 32 | 231.9 | 8.1 | 92 | 291.8 | 10.2 |
| 53 | 53.0 | 1.8 | 13 | 112.9 | 3.9 | 73 | 172.9 | 6.0 | 33 | 232.9 | 8.1 | 93 | 292.8 | 10.2 |
| 54 | 54.0 | 1.9 | 14 | 113.9 | 4.0 | 74 | 173.9 | 6.1 | 34 | 233.9 | 8.2 | 94 | 293.8 | 10.3 |
| 55 | 55.0 | 1.9 | 15 | 114.9 | 4.0 | 75 | 174.9 | 6.1 | 35 | 234.9 | 8.2 | 95 | 294.8 | 10.3 |
| 56 | 56.0 | 2.0 | 16 | 115.9 | 4.0 | 76 | 175.9 | 6.1 | 36 | 235.9 | 8.2 | 96 | 295.8 | 10.3 |
| 57 | 57.0 | 2.0 | 17 | 116.9 | 4.1 | 77 | 176.9 | 6.2 | 37 | 236.9 | 8.3 | 97 | 296.8 | 10.4 |
| 58 | 58.0 | 2.0 | 18 | 117.9 | 4.1 | 78 | 177.9 | 6.2 | 38 | 237.9 | 8.3 | 98 | 297.8 | 10.4 |
| 59 | 59.0 | 2.1 | 19 | 118.9 | 4.2 | 79 | 178.9 | 6.2 | 39 | 238.9 | 8.3 | 99 | 298.8 | 10.4 |
| 60 | 60.0 | 2.1 | 20 | 119.9 | 4.2 | 80 | 179.9 | 6.3 | 40 | 239.9 | 8.4 | 300 | 299.8 | 10.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

88° (92°, 268°, 272°).

TABLE 2. [Page 371

Difference of Latitude and Departure for 2° (178°, 182°, 358°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 300.8 | 10.5 | 361 | 360.8 | 12.6 | 421 | 420.8 | 14.7 | 481 | 480.7 | 16.8 | 541 | 540.7 | 18.9 |
| 02 | 301.8 | 10.5 | 62 | 361.8 | 12.6 | 22 | 421.8 | 14.7 | 82 | 481.7 | 16.8 | 42 | 541.7 | 18.9 |
| 03 | 302.8 | 10.6 | 63 | 362.8 | 12.7 | 23 | 422.8 | 14.7 | 83 | 482.7 | 16.8 | 43 | 542.7 | 18.9 |
| 04 | 303.8 | 10.6 | 64 | 363.8 | 12.7 | 24 | 423.8 | 14.8 | 84 | 483.7 | 16.9 | 44 | 543.7 | 19.0 |
| 05 | 304.8 | 10.6 | 65 | 364.8 | 12.7 | 25 | 424.8 | 14.8 | 85 | 484.7 | 16.9 | 45 | 544.7 | 19.0 |
| 06 | 305.8 | 10.7 | 66 | 365.8 | 12.8 | 26 | 425.7 | 14.9 | 86 | 485.7 | 16.9 | 46 | 545.7 | 19.0 |
| 07 | 306.8 | 10.7 | 67 | 366.8 | 12.8 | 27 | 426.7 | 14.9 | 87 | 486.7 | 17.0 | 47 | 546.7 | 19.1 |
| 08 | 307.8 | 10.7 | 68 | 367.8 | 12.8 | 28 | 427.7 | 14.9 | 88 | 487.7 | 17.0 | 48 | 547.7 | 19.1 |
| 09 | 308.8 | 10.8 | 69 | 368.8 | 12.9 | 29 | 428.7 | 15.0 | 89 | 488.7 | 17.0 | 49 | 548.7 | 19.1 |
| 10 | 309.8 | 10.8 | 70 | 369.8 | 12.9 | 30 | 429.7 | 15.0 | 90 | 489.7 | 17.1 | 50 | 549.7 | 19.2 |
| 311 | 310.8 | 10.8 | 371 | 370.8 | 12.9 | 431 | 430.7 | 15.0 | 491 | 490.7 | 17.1 | 551 | 550.7 | 19.2 |
| 12 | 311.8 | 10.9 | 72 | 371.8 | 13.0 | 32 | 431.7 | 15.1 | 92 | 491.7 | 17.1 | 52 | 551.7 | 19.2 |
| 13 | 312.8 | 10.9 | 73 | 372.8 | 13.0 | 33 | 432.7 | 15.1 | 93 | 492.7 | 17.2 | 53 | 552.7 | 19.3 |
| 14 | 313.8 | 10.9 | 74 | 373.8 | 13.0 | 34 | 433.7 | 15.1 | 94 | 493.7 | 17.2 | 54 | 553.7 | 19.3 |
| 15 | 314.8 | 11.0 | 75 | 374.8 | 13.1 | 35 | 434.7 | 15.2 | 95 | 494.7 | 17.2 | 55 | 554.7 | 19.3 |
| 16 | 315.8 | 11.0 | 76 | 375.8 | 13.1 | 36 | 435.7 | 15.2 | 96 | 495.7 | 17.3 | 56 | 555.7 | 19.4 |
| 17 | 316.8 | 11.0 | 77 | 376.8 | 13.1 | 37 | 436.7 | 15.2 | 97 | 496.7 | 17.3 | 57 | 556.7 | 19.4 |
| 18 | 317.8 | 11.1 | 78 | 377.8 | 13.2 | 38 | 437.7 | 15.3 | 98 | 497.7 | 17.3 | 58 | 557.7 | 19.4 |
| 19 | 318.8 | 11.1 | 79 | 378.8 | 13.2 | 39 | 438.7 | 15.3 | 99 | 498.7 | 17.4 | 59 | 558.7 | 19.5 |
| 20 | 319.8 | 11.2 | 80 | 379.8 | 13.2 | 40 | 439.7 | 15.3 | 500 | 499.7 | 17.4 | 60 | 559.7 | 19.5 |
| 321 | 320.8 | 11.2 | 381 | 380.8 | 13.3 | 441 | 440.7 | 15.4 | 501 | 500.7 | 17.5 | 561 | 560.7 | 19.5 |
| 22 | 321.8 | 11.2 | 82 | 381.8 | 13.3 | 42 | 441.7 | 15.4 | 02 | 501.7 | 17.5 | 62 | 561.7 | 19.6 |
| 23 | 322.8 | 11.3 | 83 | 382.8 | 13.3 | 43 | 442.7 | 15.4 | 03 | 502.7 | 17.5 | 63 | 562.7 | 19.6 |
| 24 | 323.8 | 11.3 | 84 | 383.8 | 13.4 | 44 | 443.7 | 15.5 | 04 | 503.7 | 17.6 | 64 | 563.7 | 19.6 |
| 25 | 324.8 | 11.3 | 85 | 384.8 | 13.4 | 45 | 444.7 | 15.5 | 05 | 504.7 | 17.6 | 65 | 564.7 | 19.7 |
| 26 | 325.8 | 11.4 | 86 | 385.8 | 13.5 | 46 | 445.7 | 15.6 | 06 | 505.7 | 17.6 | 66 | 565.7 | 19.7 |
| 27 | 326.8 | 11.4 | 87 | 386.8 | 13.5 | 47 | 446.7 | 15.6 | 07 | 506.7 | 17.7 | 67 | 566.7 | 19.7 |
| 28 | 327.8 | 11.4 | 88 | 387.8 | 13.5 | 48 | 447.7 | 15.6 | 08 | 507.7 | 17.7 | 68 | 567.7 | 19.8 |
| 29 | 328.8 | 11.5 | 89 | 388.8 | 13.6 | 49 | 448.7 | 15.7 | 09 | 508.7 | 17.7 | 69 | 568.7 | 19.8 |
| 30 | 329.8 | 11.5 | 90 | 389.8 | 13.6 | 50 | 449.7 | 15.7 | 10 | 509.7 | 17.8 | 70 | 569.7 | 19.9 |
| 331 | 330.8 | 11.5 | 391 | 390.8 | 13.6 | 451 | 450.7 | 15.7 | 511 | 510.7 | 17.8 | 571 | 570.7 | 19.9 |
| 32 | 331.8 | 11.6 | 92 | 391.8 | 13.7 | 52 | 451.7 | 15.8 | 12 | 511.7 | 17.8 | 72 | 571.7 | 19.9 |
| 33 | 332.8 | 11.6 | 93 | 392.8 | 13.7 | 53 | 452.7 | 15.8 | 13 | 512.7 | 17.9 | 73 | 572.7 | 20.0 |
| 34 | 333.8 | 11.6 | 94 | 393.8 | 13.7 | 54 | 453.7 | 15.8 | 14 | 513.7 | 17.9 | 74 | 573.6 | 20.0 |
| 35 | 334.8 | 11.7 | 95 | 394.8 | 13.8 | 55 | 454.7 | 15.9 | 15 | 514.7 | 17.9 | 75 | 574.6 | 20.0 |
| 36 | 335.8 | 11.7 | 96 | 395.8 | 13.8 | 56 | 455.7 | 15.9 | 16 | 515.7 | 18.0 | 76 | 575.6 | 20.1 |
| 37 | 336.8 | 11.7 | 97 | 396.8 | 13.8 | 57 | 456.7 | 15.9 | 17 | 516.7 | 18.0 | 77 | 576.6 | 20.1 |
| 38 | 337.8 | 11.8 | 98 | 397.8 | 13.9 | 58 | 457.7 | 16.0 | 18 | 517.7 | 18.1 | 78 | 577.6 | 20.1 |
| 39 | 338.8 | 11.8 | 99 | 398.8 | 13.9 | 59 | 458.7 | 16.0 | 19 | 518.7 | 18.1 | 79 | 578.6 | 20.2 |
| 40 | 339.8 | 11.9 | 400 | 399.8 | 13.9 | 60 | 459.7 | 16.0 | 20 | 519.7 | 18.1 | 80 | 579.6 | 20.2 |
| 341 | 340.8 | 11.9 | 401 | 400.8 | 14.0 | 461 | 460.7 | 16.1 | 521 | 520.7 | 18.2 | 581 | 580.6 | 20.2 |
| 42 | 341.8 | 11.9 | 02 | 401.8 | 14.0 | 62 | 461.7 | 16.1 | 22 | 521.7 | 18.2 | 82 | 581.6 | 20.3 |
| 43 | 342.8 | 12.0 | 03 | 402.8 | 14.0 | 63 | 462.7 | 16.1 | 23 | 522.7 | 18.2 | 83 | 582.6 | 20.3 |
| 44 | 343.8 | 12.0 | 04 | 403.8 | 14.1 | 64 | 463.7 | 16.2 | 24 | 523.7 | 18.3 | 84 | 583.6 | 20.3 |
| 45 | 344.8 | 12.0 | 05 | 404.8 | 14.1 | 65 | 464.7 | 16.2 | 25 | 524.7 | 18.3 | 85 | 584.6 | 20.4 |
| 46 | 345.8 | 12.1 | 06 | 405.8 | 14.2 | 66 | 465.7 | 16.2 | 26 | 525.7 | 18.4 | 86 | 585.6 | 20.4 |
| 47 | 346.8 | 12.1 | 07 | 406.8 | 14.2 | 67 | 466.7 | 16.3 | 27 | 526.7 | 18.4 | 87 | 586.6 | 20.4 |
| 48 | 347.8 | 12.1 | 08 | 407.8 | 14.2 | 68 | 467.7 | 16.3 | 28 | 527.7 | 18.4 | 88 | 587.6 | 20.5 |
| 49 | 348.8 | 12.2 | 09 | 408.8 | 14.3 | 69 | 468.7 | 16.4 | 29 | 528.7 | 18.5 | 89 | 588.6 | 20.5 |
| 50 | 349.8 | 12.2 | 10 | 409.8 | 14.3 | 70 | 469.7 | 16.4 | 30 | 529.7 | 18.5 | 90 | 589.6 | 20.5 |
| 351 | 350.8 | 12.2 | 411 | 410.8 | 14.3 | 471 | 470.7 | 16.4 | 531 | 530.7 | 18.5 | 591 | 590.6 | 20.6 |
| 52 | 351.8 | 12.3 | 12 | 411.8 | 14.4 | 72 | 471.7 | 16.5 | 32 | 531.7 | 18.6 | 92 | 591.6 | 20.6 |
| 53 | 352.8 | 12.3 | 13 | 412.8 | 14.4 | 73 | 472.7 | 16.5 | 33 | 532.7 | 18.6 | 93 | 592.6 | 20.6 |
| 54 | 353.8 | 12.3 | 14 | 413.8 | 14.4 | 74 | 473.7 | 16.5 | 34 | 533.7 | 18.6 | 94 | 593.6 | 20.7 |
| 55 | 354.8 | 12.4 | 15 | 414.8 | 14.5 | 75 | 474.7 | 16.6 | 35 | 534.7 | 18.7 | 95 | 594.6 | 20.7 |
| 56 | 355.8 | 12.4 | 16 | 415.8 | 14.5 | 76 | 475.7 | 16.6 | 36 | 535.7 | 18.7 | 96 | 595.6 | 20.7 |
| 57 | 356.8 | 12.4 | 17 | 416.8 | 14.5 | 77 | 476.7 | 16.6 | 37 | 536.7 | 18.7 | 97 | 596.6 | 20.8 |
| 58 | 357.8 | 12.5 | 18 | 417.8 | 14.6 | 78 | 477.7 | 16.7 | 38 | 537.7 | 18.8 | 98 | 597.6 | 20.8 |
| 59 | 358.8 | 12.5 | 19 | 418.8 | 14.6 | 79 | 478.7 | 16.7 | 39 | 538.7 | 18.8 | 99 | 598.6 | 20.8 |
| 60 | 359.8 | 12.5 | 20 | 419.8 | 14.6 | 80 | 479.7 | 16.7 | 40 | 539.7 | 18.8 | 600 | 599.6 | 20.9 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

88° (92°, 268°, 272°).

TABLE 2.

Difference of Latitude and Departure for 3° (177°, 183°, 357°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.9 | 3.2 | 121 | 120.8 | 6.3 | 181 | 180.8 | 9.5 | 241 | 240.7 | 12.6 |
| 2 | 2.0 | 0.1 | 62 | 61.9 | 3.2 | 22 | 121.8 | 6.4 | 82 | 181.8 | 9.5 | 42 | 241.7 | 12.7 |
| 3 | 3.0 | 0.2 | 63 | 62.9 | 3.3 | 23 | 122.8 | 6.4 | 83 | 182.7 | 9.6 | 43 | 242.7 | 12.7 |
| 4 | 4.0 | 0.2 | 64 | 63.9 | 3.3 | 24 | 123.8 | 6.5 | 84 | 183.7 | 9.6 | 44 | 243.7 | 12.8 |
| 5 | 5.0 | 0.3 | 65 | 64.9 | 3.4 | 25 | 124.8 | 6.5 | 85 | 184.7 | 9.7 | 45 | 244.7 | 12.8 |
| 6 | 6.0 | 0.3 | 66 | 65.9 | 3.5 | 26 | 125.8 | 6.6 | 86 | 185.7 | 9.7 | 46 | 245.7 | 12.9 |
| 7 | 7.0 | 0.4 | 67 | 66.9 | 3.5 | 27 | 126.8 | 6.6 | 87 | 186.7 | 9.8 | 47 | 246.7 | 12.9 |
| 8 | 8.0 | 0.4 | 68 | 67.9 | 3.6 | 28 | 127.8 | 6.7 | 88 | 187.7 | 9.8 | 48 | 247.7 | 13.0 |
| 9 | 9.0 | 0.5 | 69 | 68.9 | 3.6 | 29 | 128.8 | 6.8 | 89 | 188.7 | 9.9 | 49 | 248.7 | 13.0 |
| 10 | 10.0 | 0.5 | 70 | 69.9 | 3.7 | 30 | 129.8 | 6.8 | 90 | 189.7 | 9.9 | 50 | 249.7 | 13.1 |
| 11 | 11.0 | 0.6 | 71 | 70.9 | 3.7 | 131 | 130.8 | 6.9 | 191 | 190.7 | 10.0 | 251 | 250.7 | 13.1 |
| 12 | 12.0 | 0.6 | 72 | 71.9 | 3.8 | 32 | 131.8 | 6.9 | 92 | 191.7 | 10.0 | 52 | 251.7 | 13.2 |
| 13 | 13.0 | 0.7 | 73 | 72.9 | 3.8 | 33 | 132.8 | 7.0 | 93 | 192.7 | 10.1 | 53 | 252.7 | 13.2 |
| 14 | 14.0 | 0.7 | 74 | 73.9 | 3.9 | 34 | 133.8 | 7.0 | 94 | 193.7 | 10.2 | 54 | 253.7 | 13.3 |
| 15 | 15.0 | 0.8 | 75 | 74.9 | 3.9 | 35 | 134.8 | 7.1 | 95 | 194.7 | 10.2 | 55 | 254.7 | 13.3 |
| 16 | 16.0 | 0.8 | 76 | 75.9 | 4.0 | 36 | 135.8 | 7.1 | 96 | 195.7 | 10.3 | 56 | 255.6 | 13.4 |
| 17 | 17.0 | 0.9 | 77 | 76.9 | 4.0 | 37 | 136.8 | 7.2 | 97 | 196.7 | 10.3 | 57 | 256.6 | 13.5 |
| 18 | 18.0 | 0.9 | 78 | 77.9 | 4.1 | 38 | 137.8 | 7.2 | 98 | 197.7 | 10.4 | 58 | 257.6 | 13.5 |
| 19 | 19.0 | 1.0 | 79 | 78.9 | 4.1 | 39 | 138.8 | 7.3 | 99 | 198.7 | 10.4 | 59 | 258.6 | 13.6 |
| 20 | 20.0 | 1.0 | 80 | 79.9 | 4.2 | 40 | 139.8 | 7.3 | 200 | 199.7 | 10.5 | 60 | 259.6 | 13.6 |
| 21 | 21.0 | 1.1 | 81 | 80.9 | 4.2 | 141 | 140.8 | 7.4 | 201 | 200.7 | 10.5 | 261 | 260.6 | 13.7 |
| 22 | 22.0 | 1.2 | 82 | 81.9 | 4.3 | 42 | 141.8 | 7.4 | 02 | 201.7 | 10.6 | 62 | 261.6 | 13.7 |
| 23 | 23.0 | 1.2 | 83 | 82.9 | 4.3 | 43 | 142.8 | 7.5 | 03 | 202.7 | 10.6 | 63 | 262.6 | 13.8 |
| 24 | 24.0 | 1.3 | 84 | 83.9 | 4.4 | 44 | 143.8 | 7.5 | 04 | 203.7 | 10.7 | 64 | 263.6 | 13.8 |
| 25 | 25.0 | 1.3 | 85 | 84.9 | 4.4 | 45 | 144.8 | 7.6 | 05 | 204.7 | 10.7 | 65 | 264.6 | 13.9 |
| 26 | 26.0 | 1.4 | 86 | 85.9 | 4.5 | 46 | 145.8 | 7.6 | 06 | 205.7 | 10.8 | 66 | 265.6 | 13.9 |
| 27 | 27.0 | 1.4 | 87 | 86.9 | 4.6 | 47 | 146.8 | 7.7 | 07 | 206.7 | 10.8 | 67 | 266.6 | 14.0 |
| 28 | 28.0 | 1.5 | 88 | 87.9 | 4.6 | 48 | 147.8 | 7.7 | 08 | 207.7 | 10.9 | 68 | 267.6 | 14.0 |
| 29 | 29.0 | 1.5 | 89 | 88.9 | 4.7 | 49 | 148.8 | 7.8 | 09 | 208.7 | 10.9 | 69 | 268.6 | 14.1 |
| 30 | 30.0 | 1.6 | 90 | 89.9 | 4.7 | 50 | 149.8 | 7.9 | 10 | 209.7 | 11.0 | 70 | 269.6 | 14.1 |
| 31 | 31.0 | 1.6 | 91 | 90.9 | 4.8 | 151 | 150.8 | 7.9 | 211 | 210.7 | 11.0 | 271 | 270.6 | 14.2 |
| 32 | 32.0 | 1.7 | 92 | 91.9 | 4.8 | 52 | 151.8 | 8.0 | 12 | 211.7 | 11.1 | 72 | 271.6 | 14.2 |
| 33 | 33.0 | 1.7 | 93 | 92.9 | 4.9 | 53 | 152.8 | 8.0 | 13 | 212.7 | 11.1 | 73 | 272.6 | 14.3 |
| 34 | 34.0 | 1.8 | 94 | 93.9 | 4.9 | 54 | 153.8 | 8.1 | 14 | 213.7 | 11.2 | 74 | 273.6 | 14.3 |
| 35 | 35.0 | 1.8 | 95 | 94.9 | 5.0 | 55 | 154.8 | 8.1 | 15 | 214.7 | 11.3 | 75 | 274.6 | 14.4 |
| 36 | 36.0 | 1.9 | 96 | 95.9 | 5.0 | 56 | 155.8 | 8.2 | 16 | 215.7 | 11.3 | 76 | 275.6 | 14.4 |
| 37 | 36.9 | 1.9 | 97 | 96.9 | 5.1 | 57 | 156.8 | 8.2 | 17 | 216.7 | 11.4 | 77 | 276.6 | 14.5 |
| 38 | 37.9 | 2.0 | 98 | 97.9 | 5.1 | 58 | 157.8 | 8.3 | 18 | 217.7 | 11.4 | 78 | 277.6 | 14.5 |
| 39 | 38.9 | 2.0 | 99 | 98.9 | 5.2 | 59 | 158.8 | 8.3 | 19 | 218.7 | 11.5 | 79 | 278.6 | 14.6 |
| 40 | 39.9 | 2.1 | 100 | 99.9 | 5.2 | 60 | 159.8 | 8.4 | 20 | 219.7 | 11.5 | 80 | 279.6 | 14.7 |
| 41 | 40.9 | 2.1 | 101 | 100.9 | 5.3 | 161 | 160.8 | 8.4 | 221 | 220.7 | 11.6 | 281 | 280.6 | 14.7 |
| 42 | 41.9 | 2.2 | 02 | 101.9 | 5.3 | 62 | 161.8 | 8.5 | 22 | 221.7 | 11.6 | 82 | 281.6 | 14.8 |
| 43 | 42.9 | 2.3 | 03 | 102.9 | 5.4 | 63 | 162.8 | 8.5 | 23 | 222.7 | 11.7 | 83 | 282.6 | 14.8 |
| 44 | 43.9 | 2.3 | 04 | 103.9 | 5.4 | 64 | 163.8 | 8.6 | 24 | 223.7 | 11.7 | 84 | 283.6 | 14.9 |
| 45 | 44.9 | 2.4 | 05 | 104.9 | 5.5 | 65 | 164.8 | 8.6 | 25 | 224.7 | 11.8 | 85 | 284.6 | 14.9 |
| 46 | 45.9 | 2.4 | 06 | 105.9 | 5.5 | 66 | 165.8 | 8.7 | 26 | 225.7 | 11.8 | 86 | 285.6 | 15.0 |
| 47 | 46.9 | 2.5 | 07 | 106.9 | 5.6 | 67 | 166.8 | 8.7 | 27 | 226.7 | 11.9 | 87 | 286.6 | 15.0 |
| 48 | 47.9 | 2.5 | 08 | 107.9 | 5.7 | 68 | 167.8 | 8.8 | 28 | 227.7 | 11.9 | 88 | 287.6 | 15.1 |
| 49 | 48.9 | 2.6 | 09 | 108.9 | 5.7 | 69 | 168.8 | 8.8 | 29 | 228.7 | 12.0 | 89 | 288.6 | 15.1 |
| 50 | 49.9 | 2.6 | 10 | 109.8 | 5.8 | 70 | 169.8 | 8.9 | 30 | 229.7 | 12.0 | 90 | 289.6 | 15.2 |
| 51 | 50.9 | 2.7 | 111 | 110.8 | 5.8 | 171 | 170.8 | 8.9 | 231 | 230.7 | 12.1 | 291 | 290.6 | 15.2 |
| 52 | 51.9 | 2.7 | 12 | 111.8 | 5.9 | 72 | 171.8 | 9.0 | 32 | 231.7 | 12.1 | 92 | 291.6 | 15.3 |
| 53 | 52.9 | 2.8 | 13 | 112.8 | 5.9 | 73 | 172.8 | 9.1 | 33 | 232.7 | 12.2 | 93 | 292.6 | 15.3 |
| 54 | 53.9 | 2.8 | 14 | 113.8 | 6.0 | 74 | 173.8 | 9.1 | 34 | 233.7 | 12.2 | 94 | 293.6 | 15.4 |
| 55 | 54.9 | 2.9 | 15 | 114.8 | 6.0 | 75 | 174.8 | 9.2 | 35 | 234.7 | 12.3 | 95 | 294.6 | 15.4 |
| 56 | 55.9 | 2.9 | 16 | 115.8 | 6.1 | 76 | 175.8 | 9.2 | 36 | 235.7 | 12.4 | 96 | 295.6 | 15.5 |
| 57 | 56.9 | 3.0 | 17 | 116.8 | 6.1 | 77 | 176.8 | 9.3 | 37 | 236.7 | 12.4 | 97 | 296.6 | 15.5 |
| 58 | 57.9 | 3.0 | 18 | 117.8 | 6.2 | 78 | 177.8 | 9.3 | 38 | 237.7 | 12.5 | 98 | 297.6 | 15.6 |
| 59 | 58.9 | 3.1 | 19 | 118.8 | 6.2 | 79 | 178.8 | 9.4 | 39 | 238.7 | 12.5 | 99 | 298.6 | 15.6 |
| 60 | 59.9 | 3.1 | 20 | 119.8 | 6.3 | 80 | 179.8 | 9.4 | 40 | 239.7 | 12.6 | 300 | 299.6 | 15.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

87° (93°, 267°, 273°).

TABLE 2. [Page 373

Difference of Latitude and Departure for 3° (177°, 183°, 357°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 300.6 | 15.7 | 361 | 360.5 | 18.9 | 421 | 420.4 | 22.0 | 481 | 480.3 | 25.2 | 541 | 540.2 | 28.3 |
| 02 | 301.6 | 15.8 | 62 | 361.5 | 19.0 | 22 | 421.4 | 22.1 | 82 | 481.3 | 25.2 | 42 | 541.2 | 28.4 |
| 03 | 302.6 | 15.9 | 63 | 362.5 | 19.0 | 23 | 422.4 | 22.2 | 83 | 482.3 | 25.3 | 43 | 542.2 | 28.4 |
| 04 | 303.5 | 15.9 | 64 | 363.5 | 19.1 | 24 | 423.4 | 22.2 | 84 | 483.3 | 25.3 | 44 | 543.2 | 28.5 |
| 05 | 304.5 | 16.0 | 65 | 364.5 | 19.1 | 25 | 424.4 | 22.3 | 85 | 484.3 | 25.4 | 45 | 544.2 | 28.5 |
| 06 | 305.5 | 16.0 | 66 | 365.5 | 19.2 | 26 | 425.4 | 22.3 | 86 | 485.3 | 25.4 | 46 | 545.2 | 28.6 |
| 07 | 306.5 | 16.1 | 67 | 366.5 | 19.2 | 27 | 426.4 | 22.4 | 87 | 486.3 | 25.5 | 47 | 546.2 | 28.6 |
| 08 | 307.5 | 16.1 | 68 | 367.5 | 19.3 | 28 | 427.4 | 22.4 | 88 | 487.3 | 25.5 | 48 | 547.2 | 28.7 |
| 09 | 308.5 | 16.2 | 69 | 368.5 | 19.3 | 29 | 428.4 | 22.5 | 89 | 488.3 | 25.6 | 49 | 548.2 | 28.7 |
| 10 | 309.5 | 16.2 | 70 | 369.5 | 19.4 | 30 | 429.4 | 22.5 | 90 | 489.3 | 25.6 | 50 | 549.2 | 28.8 |
| 311 | 310.5 | 16.3 | 371 | 370.5 | 19.4 | 431 | 430.4 | 22.6 | 491 | 490.3 | 25.7 | 551 | 550.2 | 28.8 |
| 12 | 311.5 | 16.3 | 72 | 371.5 | 19.5 | 32 | 431.4 | 22.6 | 92 | 491.3 | 25.7 | 52 | 551.2 | 28.9 |
| 13 | 312.5 | 16.4 | 73 | 372.5 | 19.5 | 33 | 432.4 | 22.7 | 93 | 492.3 | 25.8 | 53 | 552.2 | 28.9 |
| 14 | 313.5 | 16.4 | 74 | 373.5 | 19.6 | 34 | 433.4 | 22.7 | 94 | 493.3 | 25.9 | 54 | 553.2 | 29.0 |
| 15 | 314.5 | 16.5 | 75 | 374.5 | 19.6 | 35 | 434.4 | 22.8 | 95 | 494.3 | 25.9 | 55 | 554.2 | 29.1 |
| 16 | 315.5 | 16.6 | 76 | 375.5 | 19.7 | 36 | 435.4 | 22.8 | 96 | 495.3 | 26.0 | 56 | 555.2 | 29.1 |
| 17 | 316.5 | 16.6 | 77 | 376.5 | 19.8 | 37 | 436.4 | 22.9 | 97 | 496.3 | 26.0 | 57 | 556.2 | 29.2 |
| 18 | 317.5 | 16.7 | 78 | 377.4 | 19.8 | 38 | 437.4 | 22.9 | 98 | 497.3 | 26.1 | 58 | 557.2 | 29.2 |
| 19 | 318.5 | 16.7 | 79 | 378.4 | 19.9 | 39 | 438.4 | 23.0 | 99 | 498.3 | 26.1 | 59 | 558.2 | 29.3 |
| 20 | 319.5 | 16.8 | 80 | 379.4 | 19.9 | 40 | 439.4 | 23.0 | 500 | 499.3 | 26.2 | 60 | 559.2 | 29.3 |
| 321 | 320.5 | 16.8 | 381 | 380.4 | 20.0 | 441 | 440.4 | 23.1 | 501 | 500.3 | 26.2 | 561 | 560.2 | 29.4 |
| 22 | 321.5 | 16.9 | 82 | 381.4 | 20.0 | 42 | 441.4 | 23.1 | 02 | 501.3 | 26.3 | 62 | 561.2 | 29.4 |
| 23 | 322.5 | 16.9 | 83 | 382.4 | 20.1 | 43 | 442.4 | 23.2 | 03 | 502.3 | 26.3 | 63 | 562.2 | 29.5 |
| 24 | 323.5 | 17.0 | 84 | 383.4 | 20.1 | 44 | 443.4 | 23.3 | 04 | 503.3 | 26.4 | 64 | 563.2 | 29.5 |
| 25 | 324.5 | 17.0 | 85 | 384.4 | 20.2 | 45 | 444.4 | 23.3 | 05 | 504.3 | 26.4 | 65 | 564.2 | 29.6 |
| 26 | 325.5 | 17.1 | 86 | 385.4 | 20.2 | 46 | 445.4 | 23.4 | 06 | 505.3 | 26.5 | 66 | 565.2 | 29.6 |
| 27 | 326.5 | 17.1 | 87 | 386.4 | 20.3 | 47 | 446.4 | 23.4 | 07 | 506.3 | 26.5 | 67 | 566.2 | 29.7 |
| 28 | 327.5 | 17.2 | 88 | 387.4 | 20.3 | 48 | 447.4 | 23.5 | 08 | 507.3 | 26.6 | 68 | 567.2 | 29.7 |
| 29 | 328.5 | 17.2 | 89 | 388.4 | 20.4 | 49 | 448.4 | 23.5 | 09 | 508.3 | 26.6 | 69 | 568.2 | 29.8 |
| 30 | 329.5 | 17.3 | 90 | 389.4 | 20.4 | 50 | 449.3 | 23.6 | 10 | 509.3 | 26.7 | 70 | 569.2 | 29.8 |
| 331 | 330.5 | 17.3 | 391 | 390.4 | 20.5 | 451 | 450.3 | 23.6 | 511 | 510.3 | 26.7 | 571 | 570.2 | 29.9 |
| 32 | 331.5 | 17.4 | 92 | 391.4 | 20.5 | 52 | 451.3 | 23.7 | 12 | 511.3 | 26.8 | 72 | 571.2 | 29.9 |
| 33 | 332.5 | 17.5 | 93 | 392.4 | 20.6 | 53 | 452.3 | 23.7 | 13 | 512.3 | 26.8 | 73 | 572.2 | 30.0 |
| 34 | 333.5 | 17.5 | 94 | 393.4 | 20.6 | 54 | 453.3 | 23.8 | 14 | 513.3 | 26.9 | 74 | 573.2 | 30.0 |
| 35 | 334.5 | 17.6 | 95 | 394.4 | 20.7 | 55 | 454.3 | 23.8 | 15 | 514.3 | 27.0 | 75 | 574.2 | 30.1 |
| 36 | 335.5 | 17.6 | 96 | 395.4 | 20.7 | 56 | 455.3 | 23.9 | 16 | 515.3 | 27.0 | 76 | 575.2 | 30.1 |
| 37 | 336.5 | 17.7 | 97 | 396.4 | 20.8 | 57 | 456.3 | 23.9 | 17 | 516.3 | 27.1 | 77 | 576.2 | 30.2 |
| 38 | 337.5 | 17.7 | 98 | 397.4 | 20.8 | 58 | 457.3 | 24.0 | 18 | 517.3 | 27.1 | 78 | 577.2 | 30.2 |
| 39 | 338.5 | 17.8 | 99 | 398.4 | 20.9 | 59 | 458.3 | 24.0 | 19 | 518.3 | 27.2 | 79 | 578.2 | 30.3 |
| 40 | 339.5 | 17.8 | 400 | 399.4 | 20.9 | 60 | 459.3 | 24.1 | 20 | 519.3 | 27.2 | 80 | 579.2 | 30.3 |
| 341 | 340.5 | 17.9 | 401 | 400.4 | 21.0 | 461 | 460.3 | 24.1 | 521 | 520.3 | 27.3 | 581 | 580.2 | 30.4 |
| 42 | 341.5 | 17.9 | 02 | 401.4 | 21.1 | 62 | 461.3 | 24.2 | 22 | 521.3 | 27.3 | 82 | 581.2 | 30.4 |
| 43 | 342.5 | 18.0 | 03 | 402.4 | 21.1 | 63 | 462.3 | 24.2 | 23 | 522.3 | 27.4 | 83 | 582.2 | 30.5 |
| 44 | 343.5 | 18.0 | 04 | 403.4 | 21.2 | 64 | 463.3 | 24.3 | 24 | 523.3 | 27.4 | 84 | 583.2 | 30.5 |
| 45 | 344.5 | 18.1 | 05 | 404.4 | 21.2 | 65 | 464.3 | 24.4 | 25 | 524.3 | 27.5 | 85 | 584.2 | 30.6 |
| 46 | 345.5 | 18.1 | 06 | 405.4 | 21.3 | 66 | 465.3 | 24.4 | 26 | 525.3 | 27.5 | 86 | 585.2 | 30.6 |
| 47 | 346:5 | 18.2 | 07 | 406.4 | 21.3 | 67 | 466.3 | 24.5 | 27 | 526.3 | 27.6 | 87 | 586.2 | 30.7 |
| 48 | 347.5 | 18.2 | 08 | 407.4 | 21.4 | 68 | 467.3 | 24.5 | 28 | 527.3 | 27.6 | 88 | 587.2 | 30.7 |
| 49 | 348.5 | 18.3 | 09 | 408.4 | 21.4 | 69 | 468.3 | 24.6 | 29 | 528.3 | 27.7 | 89 | 588.2 | 30.8 |
| 50 | 349.5 | 18.3 | 10 | 409.4 | 21.5 | 70 | 469.3 | 24.6 | 30 | 529.3 | 27.7 | 90 | 589.2 | 30.9 |
| 351 | 350.5 | 18.4 | 411 | 410.4 | 21.5 | 471 | 470.3 | 24.7 | 531 | 530.3 | 27.8 | 591 | 590.2 | 30.9 |
| 52 | 351.5 | 18.4 | 12 | 411.4 | 21.6 | 72 | 471.3 | 24.7 | 32 | 531.3 | 27.8 | 92 | 591.2 | 31.0 |
| 53 | 352.5 | 18.5 | 13 | 412.4 | 21.6 | 73 | 472.3 | 24.8 | 33 | 532.3 | 27.9 | 93 | 592.2 | 31.0 |
| 54 | 353.5 | 18.5 | 14 | 413.4 | 21.7 | 74 | 473.3 | 24.8 | 34 | 533.3 | 27.9 | 94 | 593.2 | 31.1 |
| 55 | 354.5 | 18.6 | 15 | 414.4 | 21.7 | 75 | 474.3 | 24.9 | 35 | 534.3 | 28.0 | 95 | 594.2 | 31.1 |
| 56 | 355.5 | 18.6 | 16 | 415.4 | 21.8 | 76 | 475.3 | 24.9 | 36 | 535.3 | 28.0 | 96 | 595.2 | 31.2 |
| 57 | 356.5 | 18.7 | 17 | 416.4 | 21.8 | 77 | 476.3 | 25.0 | 37 | 536.3 | 28.1 | 97 | 596.2 | 31.2 |
| 58 | 357.5 | 18.8 | 18 | 417.4 | 21.9 | 78 | 477.3 | 25.0 | 38 | 537.3 | 28.2 | 98 | 597.2 | 31.3 |
| 59 | 358.5 | 18.8 | 19 | 418.4 | 21.9 | 79 | 478.3 | 25.1 | 39 | 538.3 | 28.2 | 99 | 598.2 | 31.3 |
| 60 | 359.5 | 18.9 | 20 | 419.4 | 22.0 | 80 | 479.3 | 25.1 | 40 | 539.3 | 28.3 | 600 | 599.2 | 31.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

87° (93°, 267°, 273°).

TABLE 2.

Difference of Latitude and Departure for 4° (176°, 184°, 356°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.9 | 4.3 | 121 | 120.7 | 8.4 | 181 | 180.6 | 12.6 | 241 | 240.4 | 16.8 |
| 2 | 2.0 | 0.1 | 62 | 61.8 | 4.3 | 22 | 121.7 | 8.5 | 82 | 181.6 | 12.7 | 42 | 241.4 | 16.9 |
| 3 | 3.0 | 0.2 | 63 | 62.8 | 4.4 | 23 | 122.7 | 8.6 | 83 | 182.6 | 12.8 | 43 | 242.4 | 17.0 |
| 4 | 4.0 | 0.3 | 64 | 63.8 | 4.5 | 24 | 123.7 | 8.6 | 84 | 183.6 | 12.8 | 44 | 243.4 | 17.0 |
| 5 | 5.0 | 0.3 | 65 | 64.8 | 4.5 | 25 | 124.7 | 8.7 | 85 | 184.5 | 12.9 | 45 | 244.4 | 17.1 |
| 6 | 6.0 | 0.4 | 66 | 65.8 | 4.6 | 26 | 125.7 | 8.8 | 86 | 185.5 | 13.0 | 46 | 245.4 | 17.2 |
| 7 | 7.0 | 0.5 | 67 | 66.8 | 4.7 | 27 | 126.7 | 8.9 | 87 | 186.5 | 13.0 | 47 | 246.4 | 17.2 |
| 8 | 8.0 | 0.6 | 68 | 67.8 | 4.7 | 28 | 127.7 | 8.9 | 88 | 187.5 | 13.1 | 48 | 247.4 | 17.3 |
| 9 | 9.0 | 0.6 | 69 | 68.8 | 4.8 | 29 | 128.7 | 9.0 | 89 | 188.5 | 13.2 | 49 | 248.4 | 17.4 |
| 10 | 10.0 | 0.7 | 70 | 69.8 | 4.9 | 30 | 129.7 | 9.1 | 90 | 189.5 | 13.3 | 50 | 249.4 | 17.4 |
| 11 | 11.0 | 0.8 | 71 | 70.8 | 5.0 | 131 | 130.7 | 9.1 | 191 | 190.5 | 13.3 | 251 | 250.4 | 17.5 |
| 12 | 12.0 | 0.8 | 72 | 71.8 | 5.0 | 32 | 131.7 | 9.2 | 92 | 191.5 | 13.4 | 52 | 251.4 | 17.6 |
| 13 | 13.0 | 0.9 | 73 | 72.8 | 5.1 | 33 | 132.7 | 9.3 | 93 | 192.5 | 13.5 | 53 | 252.4 | 17.6 |
| 14 | 14.0 | 1.0 | 74 | 73.8 | 5.2 | 34 | 133.7 | 9.3 | 94 | 193.5 | 13.5 | 54 | 253.4 | 17.7 |
| 15 | 15.0 | 1.0 | 75 | 74.8 | 5.2 | 35 | 134.7 | 9.4 | 95 | 194.5 | 13.6 | 55 | 254.4 | 17.8 |
| 16 | 16.0 | 1.1 | 76 | 75.8 | 5.3 | 36 | 135.7 | 9.5 | 96 | 195.5 | 13.7 | 56 | 255.4 | 17.9 |
| 17 | 17.0 | 1.2 | 77 | 76.8 | 5.4 | 37 | 136.7 | 9.6 | 97 | 196.5 | 13.7 | 57 | 256.4 | 17.9 |
| 18 | 18.0 | 1.3 | 78 | 77.8 | 5.4 | 38 | 137.7 | 9.6 | 98 | 197.5 | 13.8 | 58 | 257.4 | 18.0 |
| 19 | 19.0 | 1.3 | 79 | 78.8 | 5.5 | 39 | 138.7 | 9.7 | 99 | 198.5 | 13.9 | 59 | 258.4 | 18.1 |
| 20 | 20.0 | 1.4 | 80 | 79.8 | 5.6 | 40 | 139.7 | 9.8 | 200 | 199.5 | 14.0 | 60 | 259.4 | 18.1 |
| 21 | 20.9 | 1.5 | 81 | 80.8 | 5.7 | 141 | 140.7 | 9.8 | 201 | 200.5 | 14.0 | 261 | 260.4 | 18.2 |
| 22 | 21.9 | 1.5 | 82 | 81.8 | 5.7 | 42 | 141.7 | 9.9 | 02 | 201.5 | 14.1 | 62 | 261.4 | 18.3 |
| 23 | 22.9 | 1.6 | 83 | 82.8 | 5.8 | 43 | 142.7 | 10.0 | 03 | 202.5 | 14.2 | 63 | 262.4 | 18.3 |
| 24 | 23.9 | 1.7 | 84 | 83.8 | 5.9 | 44 | 143.6 | 10.0 | 04 | 203.5 | 14.2 | 64 | 263.4 | 18.4 |
| 25 | 24.9 | 1.7 | 85 | 84.8 | 5.9 | 45 | 144.6 | 10.1 | 05 | 204.5 | 14.3 | 65 | 264.4 | 18.5 |
| 26 | 25.9 | 1.8 | 86 | 85.8 | 6.0 | 46 | 145.6 | 10.2 | 06 | 205.5 | 14.4 | 66 | 265.4 | 18.6 |
| 27 | 26.9 | 1.9 | 87 | 86.8 | 6.1 | 47 | 146.6 | 10.3 | 07 | 206.5 | 14.4 | 67 | 266.3 | 18.6 |
| 28 | 27.9 | 2.0 | 88 | 87.8 | 6.1 | 48 | 147.6 | 10.3 | 08 | 207.5 | 14.5 | 68 | 267.3 | 18.7 |
| 29 | 28.9 | 2.0 | 89 | 88.8 | 6.2 | 49 | 148.6 | 10.4 | 09 | 208.5 | 14.6 | 69 | 268.3 | 18.8 |
| 30 | 29.9 | 2.1 | 90 | 89.8 | 6.3 | 50 | 149.6 | 10.5 | 10 | 209.5 | 14.6 | 70 | 269.3 | 18.8 |
| 31 | 30.9 | 2.2 | 91 | 90.8 | 6.3 | 151 | 150.6 | 10.5 | 211 | 210.5 | 14.7 | 271 | 270.3 | 18.9 |
| 32 | 31.9 | 2.2 | 92 | 91.8 | 6.4 | 52 | 151.6 | 10.6 | 12 | 211.5 | 14.8 | 72 | 271.3 | 19.0 |
| 33 | 32.9 | 2.3 | 93 | 92.8 | 6.5 | 53 | 152.6 | 10.7 | 13 | 212.5 | 14.9 | 73 | 272.3 | 19.0 |
| 34 | 33.9 | 2.4 | 94 | 93.8 | 6.6 | 54 | 153.6 | 10.7 | 14 | 213.5 | 14.9 | 74 | 273.3 | 19.1 |
| 35 | 34.9 | 2.4 | 95 | 94.8 | 6.6 | 55 | 154.6 | 10.8 | 15 | 214.5 | 15.0 | 75 | 274.3 | 19.2 |
| 36 | 35.9 | 2.5 | 96 | 95.8 | 6.7 | 56 | 155.6 | 10.9 | 16 | 215.5 | 15.1 | 76 | 275.3 | 19.3 |
| 37 | 36.9 | 2.6 | 97 | 96.8 | 6.8 | 57 | 156.6 | 11.0 | 17 | 216.5 | 15.1 | 77 | 276.3 | 19.3 |
| 38 | 37.9 | 2.7 | 98 | 97.8 | 6.8 | 58 | 157.6 | 11.0 | 18 | 217.5 | 15.2 | 78 | 277.3 | 19.4 |
| 39 | 38.9 | 2.7 | 99 | 98.8 | 6.9 | 59 | 158.6 | 11.1 | 19 | 218.5 | 15.3 | 79 | 278.3 | 19.5 |
| 40 | 39.9 | 2.8 | 100 | 99.8 | 7.0 | 60 | 159.6 | 11.2 | 20 | 219.5 | 15.3 | 80 | 279.3 | 19.5 |
| 41 | 40.9 | 2.9 | 101 | 100.8 | 7.0 | 161 | 160.6 | 11.2 | 221 | 220.5 | 15.4 | 281 | 280.3 | 19.6 |
| 42 | 41.9 | 2.9 | 02 | 101.8 | 7.1 | 62 | 161.6 | 11.3 | 22 | 221.5 | 15.5 | 82 | 281.3 | 19.7 |
| 43 | 42.9 | 3.0 | 03 | 102.7 | 7.2 | 63 | 162.6 | 11.4 | 23 | 222.5 | 15.6 | 83 | 282.3 | 19.7 |
| 44 | 43.9 | 3.1 | 04 | 103.7 | 7.3 | 64 | 163.6 | 11.4 | 24 | 223.5 | 15.6 | 84 | 283.3 | 19.8 |
| 45 | 44.9 | 3.1 | 05 | 104.7 | 7.3 | 65 | 164.6 | 11.5 | 25 | 224.5 | 15.7 | 85 | 284.3 | 19.9 |
| 46 | 45.9 | 3.2 | 06 | 105.7 | 7.4 | 66 | 165.6 | 11.6 | 26 | 225.4 | 15.8 | 86 | 285.3 | 20.0 |
| 47 | 46.9 | 3.3 | 07 | 106.7 | 7.5 | 67 | 166.6 | 11.6 | 27 | 226.4 | 15.8 | 87 | 286.3 | 20.0 |
| 48 | 47.9 | 3.3 | 08 | 107.7 | 7.5 | 68 | 167.6 | 11.7 | 28 | 227.4 | 15.9 | 88 | 287.3 | 20.1 |
| 49 | 48.9 | 3.4 | 09 | 108.7 | 7.6 | 69 | 168.6 | 11.8 | 29 | 228.4 | 16.0 | 89 | 288.3 | 20.2 |
| 50 | 49.9 | 3.5 | 10 | 109.7 | 7.7 | 70 | 169.6 | 11.9 | 30 | 229.4 | 16.0 | 90 | 289.3 | 20.2 |
| 51 | 50.9 | 3.6 | 111 | 110.7 | 7.7 | 171 | 170.6 | 11.9 | 231 | 230.4 | 16.1 | 291 | 290.3 | 20.3 |
| 52 | 51.9 | 3.6 | 12 | 111.7 | 7.8 | 72 | 171.6 | 12.0 | 32 | 231.4 | 16.2 | 92 | 291.3 | 20.4 |
| 53 | 52.9 | 3.7 | 13 | 112.7 | 7.9 | 73 | 172.6 | 12.1 | 33 | 232.4 | 16.3 | 93 | 292.3 | 20.4 |
| 54 | 53.9 | 3.8 | 14 | 113.7 | 8.0 | 74 | 173.6 | 12.1 | 34 | 233.4 | 16.3 | 94 | 293.3 | 20.5 |
| 55 | 54.9 | 3.8 | 15 | 114.7 | 8.0 | 75 | 174.6 | 12.2 | 35 | 234.4 | 16.4 | 95 | 294.3 | 20.6 |
| 56 | 55.9 | 3.9 | 16 | 115.7 | 8.1 | 76 | 175.6 | 12.3 | 36 | 235.4 | 16.5 | 96 | 295.3 | 20.6 |
| 57 | 56.9 | 4.0 | 17 | 116.7 | 8.2 | 77 | 176.6 | 12.3 | 37 | 236.4 | 16.5 | 97 | 296.3 | 20.7 |
| 58 | 57.9 | 4.0 | 18 | 117.7 | 8.2 | 78 | 177.6 | 12.4 | 38 | 237.4 | 16.6 | 98 | 297.3 | 20.8 |
| 59 | 58.9 | 4.1 | 19 | 118.7 | 8.3 | 79 | 178.6 | 12.5 | 39 | 238.4 | 16.7 | 99 | 298.3 | 20.9 |
| 60 | 59.9 | 4.2 | 20 | 119.7 | 8.4 | 80 | 179.6 | 12.6 | 40 | 239.4 | 16.7 | 300 | 299.3 | 20.9 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

86°; (94°, 266°, 274°).

# TABLE 2.

Difference of Latitude and Departure for 4° (176°, 184°, 356°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 300.3 | 21.0 | 361 | 360.1 | 25.2 | 421 | 420.0 | 29.4 | 481 | 479.8 | 33.5 | 541 | 539.7 | 37.7 |
| 02 | 301.3 | 21.1 | 62 | 361.1 | 25.2 | 22 | 421.0 | 29.4 | 82 | 480.8 | 33.6 | 42 | 540.7 | 37.8 |
| 03 | 302.2 | 21.1 | 63 | 362.1 | 25.3 | 23 | 422.0 | 29.5 | 83 | 481.8 | 33.7 | 43 | 541.7 | 37.9 |
| 04 | 303.2 | 21.2 | 64 | 363.1 | 25.4 | 24 | 423.0 | 29.6 | 84 | 482.8 | 33.7 | 44 | 542.7 | 37.9 |
| 05 | 304.2 | 21.3 | 65 | 364.1 | 25.5 | 25 | 424.0 | 29.6 | 85 | 483.8 | 33.8 | 45 | 543.7 | 38.0 |
| 06 | 305.2 | 21.3 | 66 | 365.1 | 25.5 | 26 | 424.9 | 29.7 | 86 | 484.8 | 33.9 | 46 | 544.7 | 38.1 |
| 07 | 306.2 | 21.4 | 67 | 366.1 | 25.6 | 27 | 425.9 | 29.8 | 87 | 485.8 | 33.9 | 47 | 545.7 | 38.1 |
| 08 | 307.2 | 21.5 | 68 | 367.1 | 25.7 | 28 | 426.9 | 29.9 | 88 | 486.8 | 34.0 | 48 | 546.7 | 38.2 |
| 09 | 308.2 | 21.6 | 69 | 368.1 | 25.7 | 29 | 427.9 | 29.9 | 89 | 487.8 | 34.1 | 49 | 547.7 | 38.3 |
| 10 | 309.2 | 21.6 | 70 | 369.1 | 25.8 | 30 | 428.9 | 30.0 | 90 | 488.8 | 34.2 | 50 | 548.7 | 38.3 |
| 311 | 310.2 | 21.7 | 371 | 370.1 | 25.9 | 431 | 429.9 | 30.1 | 491 | 489.8 | 34.2 | 551 | 549.7 | 38.4 |
| 12 | 311.2 | 21.8 | 72 | 371.1 | 25.9 | 32 | 430.9 | 30.1 | 92 | 490.8 | 34.3 | 52 | 550.7 | 38.5 |
| 13 | 312.2 | 21.8 | 73 | 372.1 | 26.0 | 33 | 431.9 | 30.2 | 93 | 491.8 | 34.4 | 53 | 551.7 | 38.5 |
| 14 | 313.2 | 21.9 | 74 | 373.1 | 26.1 | 34 | 432.9 | 30.3 | 94 | 492.8 | 34.4 | 54 | 552.7 | 38.6 |
| 15 | 314.2 | 22.0 | 75 | 374.1 | 26.2 | 35 | 433.9 | 30.3 | 95 | 493.8 | 34.5 | 55 | 553.6 | 38.7 |
| 16 | 315.2 | 22.1 | 76 | 375.1 | 26.2 | 36 | 434.9 | 30.4 | 96 | 494.8 | 34.6 | 56 | 554.6 | 38.7 |
| 17 | 316.2 | 22.1 | 77 | 376.1 | 26.3 | 37 | 435.9 | 30.5 | 97 | 495.8 | 34.6 | ·57 | 555.6 | 38.8 |
| 18 | 317.2 | 22.2 | 78 | 377.1 | 26.4 | 38 | 436.9 | 30.6 | 98 | 496.8 | 34.7 | 58 | 556.6 | 38.9 |
| 19 | 318.2 | 22.3 | 79 | 378.1 | 26.4 | 39 | 437.9 | 30.6 | 99 | 497.8 | 34.8 | 59 | 557.6 | 38.9 |
| 20 | 319.2 | 22.3 | 80 | 379.1 | 26.5 | 40 | 438.9 | 30.7 | 500 | 498.8 | 34.8 | 60 | 558.6 | 39.0 |
| 321 | 320.2 | 22.4 | 381 | 380.1 | 26.6 | 441 | 439.9 | 30.8 | 501 | 499.8 | 34.9 | 561 | 559.6 | 39.1 |
| 22 | 321.2 | 22.5 | 82 | 381.1 | 26.6 | 42 | 440.9 | 30.8 | 02 | 500.8 | 35.0 | 62 | 560.6 | 39.2 |
| 23 | 322.2 | 22.5 | 83 | 382.1 | 26.7 | 43 | 441.9 | 30.9 | 03 | 501.8 | 35.0 | 63 | 561.6 | 39.2 |
| 24 | 323.2 | 22.6 | 84 | 383.1 | 26.8 | 44 | 442.9 | 31.0 | 04 | 502.8 | 35.1 | 64 | 562.6 | 39.3 |
| 25 | 324.2 | 22.7 | 85 | 384.0 | 26.9 | 45 | 443.9 | 31.0 | 05 | 503.8 | 35.2 | 65 | 563.6 | 39.4 |
| 26 | 325.2 | 22.7 | 86 | 385.0 | 26.9 | 46 | 444.9 | 31.1 | 06 | 504.8 | 35.2 | 66 | 564.6 | 39.4 |
| 27 | 326.2 | 22.8 | 87 | 386.0 | 27.0 | 47 | 445.9 | 31.2 | 07 | 505.8 | 35.3 | 67 | 565.6 | 39.5 |
| 28 | 327.2 | 22.9 | 88 | 387.0 | 27.1 | 48 | 446.9 | 31.2 | 08 | 506.8 | 35.4 | 68 | 566.6 | 39.6 |
| 29 | 328.2 | 23.0 | 89 | 388.0 | 27.1 | 49 | 447.9 | 31.3 | 09 | 507.8 | 35.5 | 69 | 567.6 | 39.7 |
| 30 | 329.2 | 23.0 | 90 | 389.0 | 27.2 | 50 | 448.9 | 31.4 | 10 | 508.8 | 35.6 | 70 | 568.6 | 39.8 |
| 331 | 330.2 | 23.1 | 391 | 390.0 | 27.3 | 451 | 449.9 | 31.5 | 511 | 509.8 | 35.6 | 571 | 569.6 | 39.8 |
| 32 | 331.2 | 23.2 | 92 | 391.0 | 27.3 | 52 | 450.9 | 31.5 | 12 | 510.8 | 35.7 | 72 | 570.6 | 39.9 |
| 33 | 332.2 | 23.2 | 93 | 392.0 | 27.4 | 53 | 451.9 | 31.6 | 13 | 511.8 | 35.8 | 73 | 571.6 | 40.0 |
| 34 | 333.2 | 23.3 | 94 | 393.0 | 27.5 | 54 | 452.9 | 31.7 | 14 | 512.7 | 35.8 | 74 | 572.6 | 40.0 |
| 35 | 334.2 | 23.4 | 95 | 394.0 | 27.6 | 55 | 453.9 | 31.7 | 15 | 513.7 | 35.9 | 75 | 573.6 | 40.1 |
| 36 | 335.2 | 23.4 | 96 | 395.0 | 27.6 | 56 | 454.9 | 31.8 | 16 | 514.7 | 36.0 | 76 | 574.6 | 40.2 |
| 37 | 336.2 | 23.5 | 97 | 396.0 | 27.7 | 57 | 455.9 | 31.9 | 17 | 515.7 | 36.0 | 77 | 575.6 | 40.2 |
| 38 | 337.2 | 23.6 | 98 | 397.0 | 27.8 | 58 | 456.9 | 31.9 | 18 | 516.7 | 36.1 | 78 | 576.6 | 40.3 |
| 39 | 338.2 | 23.6 | 99 | 398.0 | 27.8 | 59 | 457.9 | 32.0 | 19 | 517.7 | 36.2 | 79 | 577.6 | 40.4 |
| 40 | 339.2 | 23.7 | 400 | 399.0 | 27.9 | 60 | 458.9 | 32.1 | 20 | 518.7 | 36.2 | 80 | 578.6 | 40.5 |
| 341 | 340.2 | 23.8 | 401 | 400.0 | 28.0 | 461 | 459.9 | 32.2 | 521 | 519.7 | 36.3 | 581 | 579.6 | 40.5 |
| 42 | 341.2 | 23.9 | 02 | 401.0 | 28.0 | 62 | 460.9 | 32.2 | 22 | 520.7 | 36.4 | 82 | 580.6 | 40.6 |
| 43 | 342.2 | 23.9 | 03 | 402.0 | 28.1 | 63 | 461.9 | 32.3 | 23 | 521.7 | 36.4 | 83 | 581.6 | 40.7 |
| 44 | 343.1 | 24.0 | 04 | 403.0 | 28.2 | 64 | 462.9 | 32.4 | 24 | 522.7 | 36.5 | 84 | 582.6 | 40.7 |
| 45 | 344.1 | 24.1 | 05 | 404.0 | 28.2 | 65 | 463.9 | 32.4 | 25 | 523.7 | 36.6 | 85 | 583.6 | 40.8 |
| 46 | 345.1 | 24.1 | 06 | 405.0 | 28.3 | 66 | 464.9 | 32.5 | 26 | 524.7 | 36.7 | 86 | 584.6 | 40.9 |
| 47 | 346.1 | 24.2 | 07 | 406.0 | 28.4 | 67 | 465.8 | 32.6 | 27 | 525.7 | 36.8 | 87 | 585.6 | 40.9 |
| 48 | 347.1 | 24.3 | 08 | 407.0 | 28.5 | 68 | 466.8 | 32.6 | 28 | 526.7 | 36.8 | 88 | 586.6 | 41.0 |
| 49 | 348.1 | 24.3 | 09 | 408.0 | 28.5 | 69 | 467.8 | 32.7 | 29 | 527.7 | 36.9 | 89 | 587.6 | 41.1 |
| 50 | 349.1 | 24.4 | 10 | 409.0 | 28.6 | 70 | 468.8 | 32.8 | 30 | 528.7 | 37.0 | 90 | 588.6 | 41.2 |
| 351 | 350.1 | 24.5 | 411 | 410.0 | 28.7 | 471 | 469.8 | 32.9 | 531 | 529.7 | 37.0 | 591 | 589.6 | 41.3 |
| 52 | 351.1 | 24.6 | 12 | 411.0 | 28.7 | 72 | 470.8 | 32.9 | 32 | 530.7 | 37.1 | 92 | 590.6 | 41.3 |
| 53 | 352.1 | 24.6 | 13 | 412.0 | 28.8 | 73 | 471.8 | 33.0 | 33 | 531.7 | 37.2 | 93 | 591.6 | 41.4 |
| 54 | 353.1 | 24.7 | 14 | 413.0 | 28.9 | 74 | 472.8 | 33.1 | 34 | 532.7 | 37.2 | 94 | 592.6 | 41.5 |
| 55 | 354.1 | 24.8 | 15 | 414.0 | 28.9 | 75 | 473.8 | 33.1 | 35 | 533.7 | 37.3 | 95 | 593.6 | 41.5 |
| 56 | 355.1 | 24.8 | 16 | 415.0 | 29.0 | 76 | 474.8 | 33.2 | 36 | 534.7 | 37.4 | 96 | 594.6 | 41.6 |
| 57 | 356.1 | 24.9 | 17 | 416.0 | 29.1 | 77 | 475.8 | 33.3 | 37 | 535.7 | 37.5 | 97 | 595.6 | 41.7 |
| 58 | 357.1 | 25.0 | 18 | 417.0 | 29.2 | 78 | 476.8 | 33.3 | 38 | 536.7 | 37.5 | 98 | 596.6 | 41.7 |
| 59 | 358.1 | 25.0 | 19 | 418.0 | 29.2 | 79 | 477.8 | 33.4 | 39 | 537.7 | 37.6 | 99 | 597.6 | 41.8 |
| 60 | 359.1 | 25.1 | 20 | 419.0 | 29.3 | 80 | 478.8 | 35.5 | 40 | 538.7 | 37.7 | 600 | 598.6 | 41.9 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat |

86°; (94°, 266°, 274°).

# TABLE 2.

Difference of Latitude and Departure for 5° (175°, 185°, 355°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.8 | 5.3 | 121 | 120.5 | 10.5 | 181 | 180.3 | 15.8 | 241 | 240.1 | 21.0 |
| 2 | 2.0 | 0.2 | 62 | 61.8 | 5.4 | 22 | 121.5 | 10.6 | 82 | 181.3 | 15.9 | 42 | 241.1 | 21.1 |
| 3 | 3.0 | 0.3 | 63 | 62.8 | 5.5 | 23 | 122.5 | 10.7 | 83 | 182.3 | 15.9 | 43 | 242.1 | 21.2 |
| 4 | 4.0 | 0.3 | 64 | 63.8 | 5.6 | 24 | 123.5 | 10.8 | 84 | 183.3 | 16.0 | 44 | 243.1 | 21.3 |
| 5 | 5.0 | 0.4 | 65 | 64.8 | 5.7 | 25 | 124.5 | 10.9 | 85 | 184.3 | 16.1 | 45 | 244.1 | 21.4 |
| 6 | 6.0 | 0.5 | 66 | 65.7 | 5.8 | 26 | 125.5 | 11.0 | 86 | 185.3 | 16.2 | 46 | 245.1 | 21.4 |
| 7 | 7.0 | 0.6 | 67 | 66.7 | 5.8 | 27 | 126.5 | 11.1 | 87 | 186.3 | 16.3 | 47 | 246.1 | 21.5 |
| 8 | 8.0 | 0.7 | 68 | 67.7 | 5.9 | 28 | 127.5 | 11.2 | 88 | 187.3 | 16.4 | 48 | 247.1 | 21.6 |
| 9 | 9.0 | 0.8 | 69 | 68.7 | 6.0 | 29 | 128.5 | 11.2 | 89 | 188.3 | 16.5 | 49 | 248.1 | 21.7 |
| 10 | 10.0 | 0.9 | 70 | 69.7 | 6.1 | 30 | 129.5 | 11.3 | 90 | 189.3 | 16.6 | 50 | 249.0 | 21.8 |
| 11 | 11.0 | 1.0 | 71 | 70.7 | 6.2 | 131 | 130.5 | 11.4 | 191 | 190.3 | 16.6 | 251 | 250.0 | 21.9 |
| 12 | 12.0 | 1.0 | 72 | 71.7 | 6.3 | 32 | 131.5 | 11.5 | 92 | 191.3 | 16.7 | 52 | 251.0 | 22.0 |
| 13 | 13.0 | 1.1 | 73 | 72.7 | 6.4 | 33 | 132.5 | 11.6 | 93 | 192.3 | 16.8 | 53 | 252.0 | 22.1 |
| 14 | 13.9 | 1.2 | 74 | 73.7 | 6.4 | 34 | 133.5 | 11.7 | 94 | -193.3 | 16.9 | 54 | 253.0 | 22.1 |
| 15 | 14.9 | 1.3 | 75 | 74.7 | 6.5 | 35 | 134.5 | 11.8 | 95 | 194.3 | 17.0 | 55 | 254.0 | 22.2 |
| 16 | 15.9 | 1.4 | 76 | 75.7 | 6.6 | 36 | 135.5 | 11.9 | 96 | 195.3 | 17.1 | 56 | 255.0 | 22.3 |
| 17 | 16.9 | 1.5 | 77 | 76.7 | 6.7 | 37 | 136.5 | 11.9 | 97 | 196.3 | 17.2 | 57 | 256.0 | 22.4 |
| 18 | 17.9 | 1.6 | 78 | 77.7 | 6.8 | 38 | 137.5 | 12.0 | 98 | 197.2 | 17.2 | 58 | 257.0 | 22.5 |
| 19 | 18.9 | 1.7 | 79 | 78.7 | 6.9 | 39 | 138.5 | 12.1 | 99 | 198.2 | 17.3 | 59 | 258.0 | 22.6 |
| 20 | 19.9 | 1.7 | 80 | 79.7 | 7.0 | 40 | 139.5 | 12.2 | 200 | 199.2 | 17.4 | 60 | 259.0 | 22.7 |
| 21 | 20.9 | 1.8 | 81 | 80.7 | 7.1 | 141 | 140.5 | 12.3 | 201 | 200.2 | 17.5 | 261 | 260.0 | 22.7 |
| 22 | 21.9 | 1.9 | 82 | 81.7 | 7.1 | 42 | 141.5 | 12.4 | 02 | 201.2 | 17.6 | 62 | 261.0 | 22.8 |
| 23 | 22.9 | 2.0 | 83 | 82.7 | 7.2 | 43 | 142.5 | 12.5 | 03 | 202.2 | 17.7 | 63 | 262.0 | 22.9 |
| 24 | 23.9 | 2.1 | 84 | 83.7 | 7.3 | 44 | 143.5 | 12.6 | 04 | 203.2 | 17.8 | 64 | 263.0 | 23.0 |
| 25 | 24.9 | 2.2 | 85 | 84.7 | 7.4 | 45 | 144.4 | 12.6 | 05 | 204.2 | 17.9 | 65 | 264.0 | 23.1 |
| 26 | 25.9 | 2.3 | 86 | 85.7 | 7.5 | 46 | 145.4 | 12.7 | 06 | 205.2 | 18.0 | 66 | 265.0 | 23.2 |
| 27 | 26.9 | 2.4 | 87 | 86.7 | 7.6 | 47 | 146.4 | 12.8 | 07 | 206.2 | 18.0 | 67 | 266.0 | 23.3 |
| 28 | 27.9 | 2.4 | 88 | 87.7 | 7.7 | 48 | 147.4 | 12.9 | 08 | 207.2 | 18.1 | 68 | 267.0 | 23.4 |
| 29 | 28.9 | 2.5 | 89 | 88.7 | 7.8 | 49 | 148.4 | 13.0 | 09 | 208.2 | 18.2 | 69 | 268.0 | 23.4 |
| 30 | 29.9 | 2.6 | 90 | 89.7 | 7.8 | 50 | 149.4 | 13.1 | 10 | 209.2 | 18.3 | 70 | 269.0 | 23.5 |
| 31 | 30.9 | 2.7 | 91 | 90.7 | 7.9 | 151 | 150.4 | 13.2 | 211 | 210.2 | 18.4 | 271 | 270.0 | 23.6 |
| 32 | 31.9 | 2.8 | 92 | 91.6 | 8.0 | 52 | 151.4 | 13.2 | 12 | 211.2 | 18.5 | 72 | 271.0 | 23.7 |
| 33 | 32.9 | 2.9 | 93 | 92.6 | 8.1 | 53 | 152.4 | 13.3 | 13 | 212.2 | 18.6 | 73 | 272.0 | 23.8 |
| 34 | 33.9 | 3.0 | 94 | 93.6 | 8.2 | 54 | 153.4 | 13.4 | 14 | 213.2 | 18.7 | 74 | 273.0 | 23.9 |
| 35 | 34.9 | 3.1 | 95 | 94.6 | 8.3 | 55 | 154.4 | 13.5 | 15 | 214.2 | 18.7 | 75 | 274.0 | 24.0 |
| 36 | 35.9 | 3.1 | 96 | 95.6 | 8.4 | 56 | 155.4 | 13.6 | 16 | 215.2 | 18.8 | 76 | 274.9 | 24.1 |
| 37 | 36.9 | 3.2 | 97 | 96.6 | 8.5 | 57 | 156.4 | 13.7 | 17 | 216.2 | 18.9 | 77 | 275.9 | 24.1 |
| 38 | 37.9 | 3.3 | 98 | 97.6 | 8.5 | 58 | 157.4 | 13.8 | 18 | 217.2 | 19.0 | 78 | 276.9 | 24.2 |
| 39 | 38.9 | 3.4 | 99 | 98.6 | 8.6 | 59 | 158.4 | 13.9 | 19 | 218.2 | 19.1 | 79 | 277.9 | 24.3 |
| 40 | 39.8 | 3.5 | 100 | 99.6 | 8.7 | 60 | 159.4 | 13.9 | 20 | 219.2 | 19.2 | 80 | 278.9 | 24.4 |
| 41 | 40.8 | 3.6 | 101 | 100.6 | 8.8 | 161 | 160.4 | 14.0 | 221 | 220.2 | 19.3 | 281 | 279.9 | 24.5 |
| 42 | 41.8 | 3.7 | 02 | 101.6 | 8.9 | 62 | 161.4 | 14.1 | 22 | 221.2 | 19.3 | 82 | 280.9 | 24.6 |
| 43 | 42.8 | 3.7 | 03 | 102.6 | 9.0 | 63 | 162.4 | 14.2 | 23 | 222.2 | 19.4 | 83 | 281.9 | 24.7 |
| 44 | 43.8 | 3.8 | 04 | 103.6 | 9.1 | 64 | 163.4 | 14.3 | 24 | 223.1 | 19.5 | 84 | 282.9 | 24.8 |
| 45 | 44.8 | 3.9 | 05 | 104.6 | 9.2 | 65 | 164.4 | 14.4 | 25 | 224.1 | 19.6 | 85 | 283.9 | 24.8 |
| 46 | 45.8 | 4.0 | 06 | 105.6 | 9.2 | 66 | 165.4 | 14.5 | 26 | 225.1 | 19.7 | 86 | 284.9 | 24.9 |
| 47 | 46.8 | 4.1 | 07 | 106.6 | 9.3 | 67 | 166.4 | 14.6 | 27 | 226.1 | 19.8 | 87 | 285.9 | 25.0 |
| 48 | 47.8 | 4.2 | 08 | 107.6 | 9.4 | 68 | 167.4 | 14.6 | 28 | 227.1 | 19.9 | 88 | 286.9 | 25.1 |
| 49 | 48.8 | 4.3 | 09 | 108.6 | 9.5 | 69 | 168.4 | 14.7 | 29 | 228.1 | 20.0 | 89 | 287.9 | 25.2 |
| 50 | 49.8 | 4.4 | 10 | 109.6 | 9.6 | 70 | 169.4 | 14.8 | 30 | 229.1 | 20.0 | 90 | 288.9 | 25.3 |
| 51 | 50.8 | 4.4 | 111 | 110.6 | 9.7 | 171 | 170.3 | 14.9 | 231 | 230.1 | 20.1 | 291 | 289.9 | 25.4 |
| 52 | 51.8 | 4.5 | 12 | 111.6 | 9.8 | 72 | 171.3 | 15.0 | 32 | 231.1 | 20.2 | 92 | 290.9 | 25.4 |
| 53 | 52.8 | 4.6 | 13 | 112.6 | 9.8 | 73 | 172.3 | 15.1 | 33 | 232.1 | 20.3 | 93 | 291.9 | 25.5 |
| 54 | 53.8 | 4.7 | 14 | 113.6 | 9.9 | 74 | 173.3 | 15.2 | 34 | 233.1 | 20.4 | 94 | 292.9 | 25.6 |
| 55 | 54.8 | 4.8 | 15 | 114.6 | 10.0 | 75 | 174.3 | 15.3 | 35 | 234.1 | 20.5 | 95 | 293.9 | 25.7 |
| 56 | 55.8 | 4.9 | 16 | 115.6 | 10.1 | 76 | 175.3 | 15.3 | 36 | 235.1 | 20.6 | 96 | 294.9 | 25.8 |
| 57 | 56.8 | 5.0 | 17 | 116.6 | 10.2 | 77 | 176.3 | 15.4 | 37 | 236.1 | 20.7 | 97 | 295.9 | 25.9 |
| 58 | 57.8 | 5.1 | 18 | 117.6 | 10.3 | 78 | 177.3 | 15.5 | 38 | 237.1 | 20.7 | 98 | 296.9 | 26.0 |
| 59 | 58.8 | 5.1 | 19 | 118.5 | 10.4 | 79 | 178.3 | 15.6 | 39 | 238.1 | 20.8 | 99 | 297.9 | 26.1 |
| 60 | 59.8 | 5.2 | 20 | 119.5 | 10.5 | 80 | 179.3 | 15.7 | 40 | 239.1 | 20.9 | 300 | 298.9 | 26.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

85° (95°, 265°, 275°).

## TABLE 2. [Page 377

Difference of Latitude and Departure for 5° (175°, 185°, 355°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 299.9 | 26.2 | 361 | 359.6 | 31.5 | 421 | 419.4 | 36.7 | 481 | 479.2 | 41.9 | 541 | 538.9 | 47.2 |
| 02 | 300.8 | 26.3 | 62 | 360.6 | 31.6 | 22 | 420.4 | 36.8 | 82 | 480.2 | 42.0 | 42 | 539.9 | 47.3 |
| 03 | 301.8 | 26.4 | 63 | 361.6 | 31.6 | 23 | 421.4 | 36.9 | 83 | 481.2 | 42.1 | 43 | 540.9 | 47.4 |
| 04 | 302.8 | 26.5 | 64 | 362.6 | 31.7 | 24 | 422.4 | 37.0 | 84 | 482.2 | 42.2 | 44 | 541.9 | 47.5 |
| 05 | 303.8 | 26.6 | 65 | 363.6 | 31.8 | 25 | 423.4 | 37.1 | 85 | 483.2 | 42.3 | 45 | 542.9 | 47.6 |
| 06 | 304.8 | 26.7 | 66 | 364.6 | 31.9 | 26 | 424.4 | 37.1 | 86 | 484.1 | 42.4 | 46 | 543.9 | 47.7 |
| 07 | 305.8 | 26.8 | 67 | 365.6 | 32.0 | 27 | 425.4 | 37.2 | 87 | 485.1 | 42.4 | 47 | 544.9 | 47.7 |
| 08 | 306.8 | 26.9 | 68 | 366.6 | 32.1 | 28 | 426.4 | 37.3 | 88 | 486.1 | 42.5 | 48 | 545.9 | 47.8 |
| 09 | 307.8 | 26.9 | 69 | 367.6 | 32.2 | 29 | 427.4 | 37.4 | 89 | 487.1 | 42.6 | 49 | 546.9 | 47.9 |
| 10 | 308.8 | 27.0 | 70 | 368.6 | 32.3 | 30 | 428.4 | 37.5 | 90 | 488.1 | 42.7 | 50 | 547.9 | 48.0 |
| 311 | 309.8 | 27.1 | 371 | 369.6 | 32.3 | 431 | 429.4 | 37.6 | 491 | 489.1 | 42.8 | 551 | 548.9 | 48.1 |
| 12 | 310.8 | 27.2 | 72 | 370.6 | 32.4 | 32 | 430.4 | 37.7 | 92 | 490.1 | 42.9 | 52 | 549.9 | 48.2 |
| 13 | 311.8 | 27.3 | 73 | 371.6 | 32.5 | 33 | 431.3 | 37.7 | 93 | 491.1 | 43.0 | 53 | 550.9 | 48.3 |
| 14 | 312.8 | 27.4 | 74 | 372.6 | 32.6 | 34 | 432.3 | 37.8 | 94 | 492.1 | 43.1 | 54 | 551.9 | 48.4 |
| 15 | 313.8 | 27.5 | 75 | 373.6 | 32.7 | 35 | 433.3 | 37.9 | 95 | 493.1 | 43.1 | 55 | 552.9 | 48.4 |
| 16 | 314.8 | 27.5 | 76 | 374.6 | 32.8 | 36 | 434.3 | 38.0 | 96 | 494.1 | 43.2 | 56 | 553.9 | 48.5 |
| 17 | 315.8 | 27.6 | 77 | 375.6 | 32.9 | 37 | 435.3 | 38.1 | 97 | 495.1 | 43.3 | 57 | 554.9 | 48.6 |
| 18 | 316.8 | 27.7 | 78 | 376.6 | 33.0 | 38 | 436.3 | 38.2 | 98 | 496.1 | 43.4 | 58 | 555.9 | 48.7 |
| 19 | 317.8 | 27.8 | 79 | 377.6 | 33.0 | 39 | 437.3 | 38.3 | 99 | 497.1 | 43.5 | 59 | 556.9 | 48.8 |
| 20 | 318.8 | 27.9 | 80 | 378.6 | 33.1 | 40 | 438.3 | 38.4 | 500 | 498.1 | 43.6 | 60 | 557.9 | 48.8 |
| 321 | 319.8 | 28.0 | 381 | 379.5 | 33.2 | 441 | 439.3 | 38.4 | 501 | 499.1 | 43.7 | 561 | 558.8 | 48.9 |
| 22 | 320.8 | 28.1 | 82 | 380.5 | 33.3 | 42 | 440.3 | 38.5 | 02 | 500.1 | 43.8 | 62 | 559.8 | 49.0 |
| 23 | 321.8 | 28.2 | 83 | 381.5 | 33.4 | 43 | 441.3 | 38.6 | 03 | 501.1 | 43.8 | 63 | 560.8 | 49.1 |
| 24 | 322.8 | 28.2 | 84 | 382.5 | 33.5 | 44 | 442.3 | 38.7 | 04 | 502.1 | 43.9 | 64 | 561.8 | 49.2 |
| 25 | 323.8 | 28.3 | 85 | 383.5 | 33.6 | 45 | 443.3 | 38.8 | 05 | 503.1 | 44.0 | 65 | 562.8 | 49.3 |
| 26 | 324.8 | 28.4 | 86 | 384.5 | 33.7 | 46 | 444.3 | 38.9 | 06 | 504.1 | 44.1 | 66 | 563.8 | 49.4 |
| 27 | 325.8 | 28.5 | 87 | 385.5 | 33.7 | 47 | 445.3 | 39.0 | 07 | 505.1 | 44.2 | 67 | 564.8 | 49.5 |
| 28 | 326.7 | 28.6 | 88 | 386.5 | 33.8 | 48 | 446.3 | 39.1 | 08 | 506.1 | 44.3 | 68 | 565.8 | 49.6 |
| 29 | 327.7 | 28.7 | 89 | 387.5 | 33.9 | 49 | 447.3 | 39.1 | 09 | 507.1 | 44.4 | 69 | 566.8 | 49.7 |
| 30 | 328.7 | 28.8 | 90 | 388.5 | 34.0 | 50 | 448.3 | 39.2 | 10 | 508.1 | 44.5 | 70 | 567.8 | 49.7 |
| 331 | 329.7 | 28.9 | 391 | 389.5 | 34.1 | 451 | 449.3 | 39.3 | 511 | 509.0 | 44.5 | 571 | 568.8 | 49.8 |
| 32 | 330.7 | 28.9 | 92 | 390.5 | 34.2 | 52 | 450.3 | 39.4 | 12 | 510.0 | 44.6 | 72 | 569.8 | 49.9 |
| 33 | 331.7 | 29.0 | 93 | 391.5 | 34.3 | 53 | 451.3 | 39.5 | 13 | 511.0 | 44.7 | 73 | 570.8 | 50.0 |
| 34 | 332.7 | 29.1 | 94 | 392.5 | 34.3 | 54 | 452.3 | 39.6 | 14 | 512.0 | 44.8 | 74 | 571.8 | 50.1 |
| 35 | 333.7 | 29.2 | 95 | 393.5 | 34.4 | 55 | 453.3 | 39.7 | 15 | 513.0 | 44.9 | 75 | 572.8 | 50.2 |
| 36 | 334.7 | 29.3 | 96 | 394.5 | 34.5 | 56 | 454.3 | 39.8 | 16 | 514.0 | 45.0 | 76 | 573.8 | 50.3 |
| 37 | 335.7 | 29.4 | 97 | 395.5 | 34.6 | 57 | 455.3 | 39.8 | 17 | 515.0 | 45.1 | 77 | 574.8 | 50.4 |
| 38 | 336.7 | 29.5 | 98 | 396.5 | 34.7 | 58 | 456.3 | 39.9 | 18 | 516.0 | 45.2 | 78 | 575.8 | 50.4 |
| 39 | 337.7 | 29.6 | 99 | 397.5 | 34.8 | 59 | 457.3 | 40.0 | 19 | 517.0 | 45.2 | 79 | 576.8 | 50.5 |
| 40 | 338.7 | 29.6 | 400 | 398.5 | 34.9 | 60 | 458.2 | 40.1 | 20 | 518.0 | 45.3 | 80 | 577.8 | 50.6 |
| 341 | 339.7 | 29.7 | 401 | 399.5 | 35.0 | 461 | 459.2 | 40.2 | 521 | 519.0 | 45.4 | 581 | 578.8 | 50.7 |
| 42 | 340.7 | 29.8 | 02 | 400.5 | 35.0 | 62 | 460.2 | 40.3 | 22 | 520.0 | 45.5 | 82 | 579.8 | 50.8 |
| 43 | 341.7 | 29.9 | 03 | 401.5 | 35.1 | 63 | 461.2 | 40.4 | 23 | 521.0 | 45.6 | 83 | 580.8 | 50.9 |
| 44 | 342.7 | 30.0 | 04 | 402.5 | 35.2 | 64 | 462.2 | 40.4 | 24 | 522.0 | 45.7 | 84 | 581.8 | 50.9 |
| 45 | 343.7 | 30.1 | 05 | 403.5 | 35.3 | 65 | 463.2 | 40.5 | 25 | 523.0 | 45.8 | 85 | 582.8 | 51.0 |
| 46 | 344.7 | 30.2 | 06 | 404.5 | 35.4 | 66 | 464.2 | 40.6 | 26 | 524.0 | 45.9 | 86 | 583.8 | 51.1 |
| 47 | 345.7 | 30.3 | 07 | 405.4 | 35.5 | 67 | 465.2 | 40.7 | 27 | 525.0 | 45.9 | 87 | 584.8 | 51.2 |
| 48 | 346.7 | 30.3 | 08 | 406.4 | 35.6 | 68 | 466.2 | 40.8 | 28 | 526.0 | 46.0 | 88 | 585.8 | 51.3 |
| 49 | 347.7 | 30.4 | 09 | 407.4 | 35.7 | 69 | 467.2 | 40.9 | 29 | 527.0 | 46.1 | 89 | 586.8 | 51.4 |
| 50 | 348.7 | 30.5 | 10 | 408.4 | 35.7 | 70 | 468.2 | 41.0 | 30 | 528.0 | 46.2 | 90 | 587.8 | 51.5 |
| 351 | 349.7 | 30.6 | 411 | 409.4 | 35.8 | 471 | 469.2 | 41.1 | 531 | 529.0 | 46.3 | 591 | 588.7 | 51.6 |
| 52 | 350.7 | 30.7 | 12 | 410.4 | 35.9 | 72 | 470.2 | 41.1 | 32 | 530.0 | 46.4 | 92 | 589.7 | 51.6 |
| 53 | 351.7 | 30.8 | 13 | 411.4 | 36.0 | 73 | 471.2 | 41.2 | 33 | 531.0 | 46.5 | 93 | 590.7 | 51.7 |
| 54 | 352.6 | 30.9 | 14 | 412.4 | 36.1 | 74 | 472.2 | 41.3 | 34 | 532.0 | 46.6 | 94 | 591.7 | 51.8 |
| 55 | 353.6 | 30.9 | 15 | 413.4 | 36.2 | 75 | 473.2 | 41.4 | 35 | 533.0 | 46.6 | 95 | 592.7 | 51.9 |
| 56 | 354.6 | 31.0 | 16 | 414.4 | 36.3 | 76 | 474.2 | 41.5 | 36 | 533.9 | 46.7 | 96 | 593.7 | 52.0 |
| 57 | 355.6 | 31.1 | 17 | 415.4 | 36.4 | 77 | 475.2 | 41.6 | 37 | 534.9 | 46.8 | 97 | 594.7 | 52.1 |
| 58 | 356.6 | 31.2 | 18 | 416.4 | 36.4 | 78 | 476.2 | 41.7 | 38 | 535.9 | 46.9 | 98 | 595.7 | 52.2 |
| 59 | 357.6 | 31.3 | 19 | 417.4 | 36.5 | 79 | 477.2 | 41.8 | 39 | 536.9 | 47.0 | 99 | 596.7 | 52.3 |
| 60 | 358.6 | 31.4 | 20 | 418.4 | 36.6 | 80 | 478.2 | 41.8 | 40 | 537.9 | 47.1 | 600 | 597.7 | 52.3 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

85° (95°, 265°, 275°).

TABLE 2.

Difference of Latitude and Departure for 6° (174°, 186°, 354°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.7 | 6.4 | 121 | 120.3 | 12.6 | 181 | 180.0 | 18.9 | 241 | 239.7 | 25.2 |
| 2 | 2.0 | 0.2 | 62 | 61.7 | 6.5 | 22 | 121.3 | 12.8 | 82 | 181.0 | 19.0 | 42 | 240.7 | 25.3 |
| 3 | 3.0 | 0.3 | 63 | 62.7 | 6.6 | 23 | 122.3 | 12.9 | 83 | 182.0 | 19.1 | 43 | 241.7 | 25.4 |
| 4 | 4.0 | 0.4 | 64 | 63.6 | 6.7 | 24 | 123.3 | 13.0 | 84 | 183.0 | 19.2 | 44 | 242.7 | 25.5 |
| 5 | 5.0 | 0.5 | 65 | 64.6 | 6.8 | 25 | 124.3 | 13.1 | 85 | 184.0 | 19.3 | 45 | 243.7 | 25.6 |
| 6 | 6.0 | 0.6 | 66 | 65.6 | 6.9 | 26 | 125.3 | 13.2 | 86 | 185.0 | 19.4 | 46 | 244.7 | 25.7 |
| 7 | 7.0 | 0.7 | 67 | 66.6 | 7.0 | 27 | 126.3 | 13.3 | 87 | 186.0 | 19.5 | 47 | 245.6 | 25.8 |
| 8 | 8.0 | 0.8 | 68 | 67.6 | 7.1 | 28 | 127.3 | 13.4 | 88 | 187.0 | 19.7 | 48 | 246.6 | 25.9 |
| 9 | 9.0 | 0.9 | 69 | 68.6 | 7.2 | 29 | 128.3 | 13.5 | 89 | 188.0 | 19.8 | 49 | 247.6 | 26.0 |
| 10 | 9.9 | 1.0 | 70 | 69.6 | 7.3 | 30 | 129.3 | 13.6 | 90 | 189.0 | 19.9 | 50 | 248.6 | 26.1 |
| 11 | 10.9 | 1.1 | 71 | 70.6 | 7.4 | 131 | 130.3 | 13.7 | 191 | 190.0 | 20.0 | 251 | 249.6 | 26.2 |
| 12 | 11.9 | 1.3 | 72 | 71.6 | 7.5 | 32 | 131.3 | 13.8 | 92 | 190.9 | 20.1 | 52 | 250.6 | 26.3 |
| 13 | 12.9 | 1.4 | 73 | 72.6 | 7.6 | 33 | 132.3 | 13.9 | 93 | 191.9 | 20.2 | 53 | 251.6 | 26.4 |
| 14 | 13.9 | 1.5 | 74 | 73.6 | 7.7 | 34 | 133.3 | 14.0 | 94 | 192.9 | 20.3 | 54 | 252.6 | 26.6 |
| 15 | 14.9 | 1.6 | 75 | 74.6 | 7.8 | 35 | 134.3 | 14.1 | 95 | 193.9 | 20.4 | 55 | 253.6 | 26.7 |
| 16 | 15.9 | 1.7 | 76 | 75.6 | 7.9 | 36 | 135.3 | 14.2 | 96 | 194.9 | 20.5 | 56 | 254.6 | 26.8 |
| 17 | 16.9 | 1.8 | 77 | 76.6 | 8.0 | 37 | 136.2 | 14.3 | 97 | 195.9 | 20.6 | 57 | 255.6 | 26.9 |
| 18 | 17.9 | 1.9 | 78 | 77.6 | 8.2 | 38 | 137.2 | 14.4 | 98 | 196.9 | 20.7 | 58 | 256.6 | 27.0 |
| 19 | 18.9 | 2.0 | 79 | 78.6 | 8.3 | 39 | 138.2 | 14.5 | 99 | 197.9 | 20.8 | 59 | 257.6 | 27.1 |
| 20 | 19.9 | 2.1 | 80 | 79.6 | 8.4 | 40 | 139.2 | 14.6 | 200 | 198.9 | 20.9 | 60 | 258.6 | 27.2 |
| 21 | 20.9 | 2.2 | 81 | 80.6 | 8.5 | 141 | 140.2 | 14.7 | 201 | 199.9 | 21.0 | 261 | 259.6 | 27.3 |
| 22 | 21.9 | 2.3 | 82 | 81.6 | 8.6 | 42 | 141.2 | 14.8 | 02 | 200.9 | 21.1 | 62 | 260.6 | 27.4 |
| 23 | 22.9 | 2.4 | 83 | 82.5 | 8.7 | 43 | 142.2 | 14.9 | 03 | 201.9 | 21.2 | 63 | 261.6 | 27.5 |
| 24 | 23.9 | 2.5 | 84 | 83.5 | 8.8 | 44 | 143.2 | 15.1 | 04 | 202.9 | 21.3 | 64 | 262.6 | 27.6 |
| 25 | 24.9 | 2.6 | 85 | 84.5 | 8.9 | 45 | 144.2 | 15.2 | 05 | 203.9 | 21.4 | 65 | 263.5 | 27.7 |
| 26 | 25.9 | 2.7 | 86 | 85.5 | 9.0 | 46 | 145.2 | 15.3 | 06 | 204.9 | 21.5 | 66 | 264.5 | 27.8 |
| 27 | 26.9 | 2.8 | 87 | 86.5 | 9.1 | 47 | 146.2 | 15.4 | 07 | 205.9 | 21.6 | 67 | 265.5 | 27.9 |
| 28 | 27.8 | 2.9 | 88 | 87.5 | 9.2 | 48 | 147.2 | 15.5 | 08 | 206.9 | 21.7 | 68 | 266.5 | 28.0 |
| 29 | 28.8 | 3.0 | 89 | 88.5 | 9.3 | 49 | 148.2 | 15.6 | 09 | 207.9 | 21.8 | 69 | 267.5 | 28.1 |
| 30 | 29.8 | 3.1 | 90 | 89.5 | 9.4 | 50 | 149.2 | 15.7 | 10 | 208.8 | 22.0 | 70 | 268.5 | 28.2 |
| 31 | 30.8 | 3.2 | 91 | 90.5 | 9.5 | 151 | 150.2 | 15.8 | 211 | 209.8 | 22.1 | 271 | 269.5 | 28.3 |
| 32 | 31.8 | 3.3 | 92 | 91.5 | 9.6 | 52 | 151.2 | 15.9 | 12 | 210.8 | 22.2 | 72 | 270.5 | 28.4 |
| 33 | 32.8 | 3.4 | 93 | 92.5 | 9.7 | 53 | 152.2 | 16.0 | 13 | 211.8 | 22.3 | 73 | 271.5 | 28.5 |
| 34 | 33.8 | 3.6 | 94 | 93.5 | 9.8 | 54 | 153.2 | 16.1 | 14 | 212.8 | 22.4 | 74 | 272.5 | 28.6 |
| 35 | 34.8 | 3.7 | 95 | 94.5 | 9.9 | 55 | 154.2 | 16.2 | 15 | 213.8 | 22.5 | 75 | 273.5 | 28.7 |
| 36 | 35.8 | 3.8 | 96 | 95.5 | 10.0 | 56 | 155.1 | 16.3 | 16 | 214.8 | 22.6 | 76 | 274.5 | 28.8 |
| 37 | 36.8 | 3.9 | 97 | 96.5 | 10.1 | 57 | 156.1 | 16.4 | 17 | 215.8 | 22.7 | 77 | 275.5 | 29.0 |
| 38 | 37.8 | 4.0 | 98 | 97.5 | 10.2 | 58 | 157.1 | 16.5 | 18 | 216.8 | 22.8 | 78 | 276.5 | 29.1 |
| 39 | 38.8 | 4.1 | 99 | 98.5 | 10.3 | 59 | 158.1 | 16.6 | 19 | 217.8 | 22.9 | 79 | 277.5 | 29.2 |
| 40 | 39.8 | 4.2 | 100 | 99.5 | 10.5 | 60 | 159.1 | 16.7 | 20 | 218.8 | 23.0 | 80 | 278.5 | 29.3 |
| 41 | 40.8 | 4.3 | 101 | 100.4 | 10.6 | 161 | 160.1 | 16.8 | 221 | 219.8 | 23.1 | 281 | 279.5 | 29.4 |
| 42 | 41.8 | 4.4 | 02 | 101.4 | 10.7 | 62 | 161.1 | 16.9 | 22 | 220.8 | 23.2 | 82 | 280.5 | 29.5 |
| 43 | 42.8 | 4.5 | 03 | 102.4 | 10.8 | 63 | 162.1 | 17.0 | 23 | 221.8 | 23.3 | 83 | 281.4 | 29.6 |
| 44 | 43.8 | 4.6 | 04 | 103.4 | 10.9 | 64 | 163.1 | 17.1 | 24 | 222.8 | 23.4 | 84 | 282.4 | 29.7 |
| 45 | 44.8 | 4.7 | 05 | 104.4 | 11.0 | 65 | 164.1 | 17.2 | 25 | 223.8 | 23.5 | 85 | 283.4 | 29.8 |
| 46 | 45.7 | 4.8 | 06 | 105.4 | 11.1 | 66 | 165.1 | 17.4 | 26 | 224.8 | 23.6 | 86 | 284.4 | 29.9 |
| 47 | 46.7 | 4.9 | 07 | 106.4 | 11.2 | 67 | 166.1 | 17.5 | 27 | 225.8 | 23.7 | 87 | 285.4 | 30.0 |
| 48 | 47.7 | 5.0 | 08 | 107.4 | 11.3 | 68 | 167.1 | 17.6 | 28 | 226.8 | 23.8 | 88 | 286.4 | 30.1 |
| 49 | 48.7 | 5.1 | 09 | 108.4 | 11.4 | 69 | 168.1 | 17.7 | 29 | 227.7 | 23.9 | 89 | 287.4 | 30.2 |
| 50 | 49.7 | 5.2 | 10 | 109.4 | 11.5 | 70 | 169.1 | 17.8 | 30 | 228.7 | 24.0 | 90 | 288.4 | 30.3 |
| 51 | 50.7 | 5.3 | 111 | 110.4 | 11.6 | 171 | 170.1 | 17.9 | 231 | 229.7 | 24.1 | 291 | 289.4 | 30.4 |
| 52 | 51.7 | 5.4 | 12 | 111.4 | 11.7 | 72 | 171.1 | 18.0 | 32 | 230.7 | 24.3 | 92 | 290.4 | 30.5 |
| 53 | 52.7 | 5.5 | 13 | 112.4 | 11.8 | 73 | 172.1 | 18.1 | 33 | 231.7 | 24.4 | 93 | 291.4 | 30.6 |
| 54 | 53.7 | 5.6 | 14 | 113.4 | 11.9 | 74 | 173.0 | 18.2 | 34 | 232.7 | 24.5 | 94 | 292.4 | 30.7 |
| 55 | 54.7 | 5.7 | 15 | 114.4 | 12.0 | 75 | 174.0 | 18.3 | 35 | 233.7 | 24.6 | 95 | 293.4 | 30.8 |
| 56 | 55.7 | 5.9 | 16 | 115.4 | 12.1 | 76 | 175.0 | 18.4 | 36 | 234.7 | 24.7 | 96 | 294.4 | 30.9 |
| 57 | 56.7 | 6.0 | 17 | 116.4 | 12.2 | 77 | 176.0 | 18.5 | 37 | 235.7 | 24.8 | 97 | 295.4 | 31.0 |
| 58 | 57.7 | 6.1 | 18 | 117.4 | 12.3 | 78 | 177.0 | 18.6 | 38 | 236.7 | 24.9 | 98 | 296.4 | 31.1 |
| 59 | 58.7 | 6.2 | 19 | 118.3 | 12.4 | 79 | 178.0 | 18.7 | 39 | 237.7 | 25.0 | 99 | 297.4 | 31.3 |
| 60 | 59.7 | 6.3 | 20 | 119.3 | 12.5 | 80 | 179.0 | 18.8 | 40 | 238.7 | 25.1 | 300 | 298.4 | 31.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

84° (96°, 264°, 276°).

TABLE 2. [Page 379

Difference of Latitude and Departure for 6° (174°, 186°, 354°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 299.3 | 31.5 | 361 | 359.0 | 37.7 | 421 | 418.7 | 44.0 | 481 | 478.4 | 50.3 | 541 | 538.0 | 56.5 |
| 02 | 300.3 | 31.6 | 62 | 360.0 | 37.8 | 22 | 419.7 | 44.1 | 82 | 479.4 | 50.4 | 42 | 539.0 | 56.6 |
| 03 | 301.3 | 31.7 | 63 | 361.0 | 37.9 | 23 | 420.7 | 44.2 | 83 | 480.4 | 50.5 | 43 | 540.0 | 56.7 |
| 04 | 302.3 | 31.8 | 64 | 362.0 | 38.0 | 24 | 421.7 | 44.3 | 84 | 481.3 | 50.6 | 44 | 541.0 | 56.8 |
| 05 | 303.3 | 31.9 | 65 | 363.0 | 38.1 | 25 | 422.7 | 44.4 | 85 | 482.3 | 50.7 | 45 | 542.0 | 56.9 |
| 06 | 304.3 | 32.0 | 66 | 364.0 | 38.3 | 26 | 423.7 | 44.5 | 86 | 483.3 | 50.8 | 46 | 543.0 | 57.0 |
| 07 | 305.3 | 32.1 | 67 | 365.0 | 38.4 | 27 | 424.7 | 44.6 | 87 | 484.3 | 50.9 | 47 | 544.0 | 57.1 |
| 08 | 306.3 | 32.2 | 68 | 366.0 | 38.5 | 28 | 425.7 | 44.7 | 88 | 485.3 | 51.0 | 48 | 545.0 | 57.2 |
| 09 | 307.3 | 32.3 | 69 | 367.0 | 38.6 | 29 | 426.6 | 44.8 | 89 | 486.3 | 51.1 | 49 | 546.0 | 57.3 |
| 10 | 308.3 | 32.4 | 70 | 368.0 | 38.7 | 30 | 427.6 | 44.9 | 90 | 487.3 | 51.2 | 50 | 547.0 | 57.4 |
| 311 | 309.3 | 32.5 | 371 | 369.0 | 38.8 | 431 | 428.6 | 45.0 | 491 | 488.3 | 51.3 | 551 | 548.0 | 57.5 |
| 12 | 310.3 | 32.6 | 72 | 370.0 | 38.9 | 32 | 429.6 | 45.2 | 92 | 489.3 | 51.4 | 52 | 549.0 | 57.6 |
| 13 | 311.3 | 32.7 | 73 | 371.0 | 39.0 | 33 | 430.6 | 45.3 | 93 | 490.3 | 51.5 | 53 | 550.0 | 57.7 |
| 14 | 312.3 | 32.8 | 74 | 371.9 | 39.1 | 34 | 431.6 | 45.4 | 94 | 491.3 | 51.6 | 54 | 551.0 | 57.9 |
| 15 | 313.3 | 32.9 | 75 | 372.9 | 39.2 | 35 | 432.6 | 45.5 | 95 | 492.3 | 51.7 | 55 | 552.0 | 58.0 |
| 16 | 314.3 | 33.0 | 76 | 373.9 | 39.3 | 36 | 433.6 | 45.6 | 96 | 493.3 | 51.8 | 56 | 553.0 | 58.1 |
| 17 | 315.3 | 33.1 | 77 | 374.9 | 39.4 | 37 | 434.6 | 45.7 | 97 | 494.3 | 51.9 | 57 | 554.0 | 58.2 |
| 18 | 316.3 | 33.2 | 78 | 375.9 | 39.5 | 38 | 435.6 | 45.8 | 98 | 495.3 | 52.0 | 58 | 555.0 | 58.3 |
| 19 | 317.3 | 33.3 | 79 | 376.9 | 39.6 | 39 | 436.6 | 45.9 | 99 | 496.3 | 52.1 | 59 | 556.0 | 58.4 |
| 20 | 318.2 | 33.4 | 80 | 377.9 | 39.7 | 40 | 437.6 | 46.0 | 500 | 497.3 | 52.3 | 60 | 556.9 | 58.5 |
| 321 | 319.2 | 33.6 | 381 | 378.9 | 39.8 | 441 | 438.6 | 46.1 | 501 | 498.3 | 52.4 | 561 | 557.9 | 58.6 |
| 22 | 320.2 | 33.7 | 82 | 379.9 | 39.9 | 42 | 439.6 | 46.2 | 02 | 499.3 | 52.5 | 62 | 558.9 | 58.7 |
| 23 | 321.2 | 33.8 | 83 | 380.9 | 40.0 | 43 | 440.6 | 46.3 | 03 | 500.2 | 52.6 | 63 | 559.9 | 58.8 |
| 24 | 322.2 | 33.9 | 84 | 381.9 | 40.1 | 44 | 441.6 | 46.4 | 04 | 501.2 | 52.7 | 64 | 560.9 | 59.0 |
| 25 | 323.2 | 34.0 | 85 | 382.9 | 40.2 | 45 | 442.6 | 46.5 | 05 | 502.2 | 52.8 | 65 | 561.9 | 59.1 |
| 26 | 324.2 | 34.1 | 86 | 383.9 | 40.3 | 46 | 443.6 | 46.6 | 06 | 503.2 | 52.9 | 66 | 562.9 | 59.2 |
| 27 | 325.2 | 34.2 | 87 | 384.9 | 40.5 | 47 | 444.5 | 46.7 | 07 | 504.2 | 53.0 | 67 | 563.9 | 59.3 |
| 28 | 326.2 | 34.3 | 88 | 385.9 | 40.6 | 48 | 445.5 | 46.8 | 08 | 505.2 | 53.1 | 68 | 564.9 | 59.4 |
| 29 | 327.2 | 34.4 | 89 | 386.9 | 40.7 | 49 | 446.5 | 46.9 | 09 | 506.2 | 53.2 | 69 | 565.9 | 59.5 |
| 30 | 328.2 | 34.5 | 90 | 387.9 | 40.8 | 50 | 447.5 | 47.0 | 10 | 507.2 | 53.3 | 70 | 566.9 | 59.6 |
| 331 | 329.2 | 34.6 | 391 | 388.8 | 40.9 | 451 | 448.5 | 47.1 | 511 | 508.2 | 53.4 | 571 | 567.9 | 59.7 |
| 32 | 330.2 | 34.7 | 92 | 389.9 | 41.0 | 52 | 449.5 | 47.2 | 12 | 509.2 | 53.5 | 72 | 568.9 | 59.8 |
| 33 | 331.2 | 34.8 | 93 | 390.8 | 41.1 | 53 | 450.5 | 47.3 | 13 | 510.2 | 53.6 | 73 | 569.9 | 59.9 |
| 34 | 332.2 | 34.9 | 94 | 391.8 | 41.2 | 54 | 451.5 | 47.5 | 14 | 511.2 | 53.7 | 74 | 570.9 | 60.0 |
| 35 | 333.2 | 35.0 | 95 | 392.8 | 41.3 | 55 | 452.5 | 47.6 | 15 | 512.2 | 53.8 | 75 | 571.9 | 60.1 |
| 36 | 334.2 | 35.1 | 96 | 393.8 | 41.4 | 56 | 453.5 | 47.7 | 16 | 513.2 | 53.9 | 76 | 572.9 | 60.2 |
| 37 | 335.2 | 35.2 | 97 | 394.8 | 41.5 | 57 | 454.5 | 47.8 | 17 | 514.2 | 54.0 | 77 | 573.9 | 60.3 |
| 38 | 336.1 | 35.3 | 98 | 395.8 | 41.6 | 58 | 455.5 | 47.9 | 18 | 515.2 | 54.1 | 78 | 574.9 | 60.4 |
| 39 | 337.1 | 35.4 | 99 | 396.8 | 41.7 | 59 | 456.5 | 48.0 | 19 | 516.2 | 54.2 | 79 | 575.8 | 60.5 |
| 40 | 338.1 | 35.5 | 400 | 397.8 | 41.8 | 60 | 457.5 | 48.1 | 20 | 517.2 | 54.3 | 80 | 576.8 | 60.6 |
| 341 | 339.1 | 35.6 | 401 | 398.8 | 41.9 | 461 | 458.5 | 48.2 | 521 | 518.1 | 54.5 | 581 | 577.8 | 60.7 |
| 42 | 340.1 | 35.7 | 02 | 399.8 | 42.0 | 62 | 459.5 | 48.3 | 22 | 519.1 | 54.6 | 82 | 578.8 | 60.8 |
| 43 | 341.1 | 35.8 | 03 | 400.8 | 42.1 | 63 | 460.5 | 48.4 | 23 | 520.1 | 54.7 | 83 | 579.8 | 60.9 |
| 44 | 342.1 | 36.0 | 04 | 401.8 | 42.2 | 64 | 461.5 | 48.5 | 24 | 521.1 | 54.8 | 84 | 580.8 | 61.1 |
| 45 | 343.1 | 36.1 | 05 | 402.8 | 42.3 | 65 | 462.5 | 48.6 | 25 | 522.1 | 54.9 | 85 | 581.8 | 61.2 |
| 46 | 344.1 | 36.2 | 06 | 403.8 | 42.4 | 66 | 463.4 | 48.7 | 26 | 523.1 | 55.0 | 86 | 582.8 | 61.3 |
| 47 | 345.1 | 36.3 | 07 | 404.8 | 42.5 | 67 | 464.4 | 48.8 | 27 | 524.1 | 55.1 | 87 | 583.8 | 61.4 |
| 48 | 346.1 | 36.4 | 08 | 405.8 | 42.6 | 68 | 465.4 | 48.9 | 28 | 525.1 | 55.2 | 88 | 584.8 | 61.5 |
| 49 | 347.1 | 36.5 | 09 | 406.8 | 42.7 | 69 | 466.4 | 49.0 | 29 | 526.1 | 55.3 | 89 | 585.8 | 61.6 |
| 50 | 348.1 | 36.6 | 10 | 407.8 | 42.9 | 70 | 467.4 | 49.1 | 30 | 527.1 | 55.4 | 90 | 586.8 | 61.7 |
| 351 | 349.1 | 36.7 | 411 | 408.7 | 43.0 | 471 | 468.4 | 49.2 | 531 | 528.1 | 55.5 | 591 | 587.8 | 61.8 |
| 52 | 350.1 | 36.8 | 12 | 409.7 | 43.1 | 72 | 469.4 | 49.3 | 32 | 529.1 | 55.6 | 92 | 588.8 | 61.9 |
| 53 | 351.1 | 36.9 | 13 | 410.7 | 43.2 | 73 | 470.4 | 49.4 | 33 | 530.1 | 55.7 | 93 | 589.8 | 62.0 |
| 54 | 352.1 | 37.0 | 14 | 411.7 | 43.3 | 74 | 471.4 | 49.5 | 34 | 531.1 | 55.8 | 94 | 590.8 | 62.1 |
| 55 | 353.1 | 37.1 | 15 | 412.7 | 43.4 | 75 | 472.4 | 49.6 | 35 | 532.1 | 55.9 | 95 | 591.8 | 62.2 |
| 56 | 354.0 | 37.2 | 16 | 413.7 | 43.5 | 76 | 473.4 | 49.8 | 36 | 533.1 | 56.0 | 96 | 592.8 | 62.3 |
| 57 | 355.0 | 37.3 | 17 | 414.7 | 43.6 | 77 | 474.4 | 49.9 | 37 | 534.1 | 56.1 | 97 | 593.8 | 62.4 |
| 58 | 356.0 | 37.4 | 18 | 415.7 | 43.7 | 78 | 475.4 | 50.0 | 38 | 535.1 | 56.2 | 98 | 594.7 | 62.5 |
| 59 | 357.0 | 37.5 | 19 | 416.7 | 43.8 | 79 | 476.4 | 50.1 | 39 | 536.1 | 56.3 | 99 | 595.7 | 62.6 |
| 60 | 358.0 | 37.6 | 20 | 417.7 | 43.9 | 80 | 477.4 | 50.2 | 40 | 537.1 | 56.4 | 600 | 596.7 | 62.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

84° (96°, 264°, 276°).

TABLE 2.

Difference of Latitude and Departure for 7° (173°, 187°, 353°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.5 | 7.4 | 121 | 120.1 | 14.7 | 181 | 179.7 | 22.1 | 241 | 239.2 | 29.4 |
| 2 | 2.0 | 0.2 | 62 | 61.5 | 7.6 | 22 | 121.1 | 14.9 | 82 | 180.6 | 22.2 | 42 | 240.2 | 29.5 |
| 3 | 3.0 | 0.4 | 63 | 62.5 | 7.7 | 23 | 122.1 | 15.0 | 83 | 181.6 | 22.3 | 43 | 241.2 | 29.6 |
| 4 | 4.0 | 0.5 | 64 | 63.5 | 7.8 | 24 | 123.1 | 15.1 | 84 | 182.6 | 22.4 | 44 | 242.2 | 29.7 |
| 5 | 5.0 | 0.6 | 65 | 64.5 | 7.9 | 25 | 124.1 | 15.2 | 85 | 183.6 | 22.5 | 45 | 243.2 | 29.9 |
| 6 | 6.0 | 0.7 | 66 | 65.5 | 8.0 | 26 | 125.1 | 15.4 | 86 | 184.6 | 22.7 | 46 | 244.2 | 30.0 |
| 7 | 6.9 | 0.9 | 67 | 66.5 | 8.2 | 27 | 126.1 | 15.5 | 87 | 185.6 | 22.8 | 47 | 245.2 | 30.1 |
| 8 | 7.9 | 1.0 | 68 | 67.5 | 8.3 | 28 | 127.0 | 15.6 | 88 | 186.6 | 22.9 | 48 | 246.2 | 30.2 |
| 9 | 8.9 | 1.1 | 69 | 68.5 | 8.4 | 29 | 128.0 | 15.7 | 89 | 187.6 | 23.0 | 49 | 247.1 | 30.3 |
| 10 | 9.9 | 1.2 | 70 | 69.5 | 8.5 | 30 | 129.0 | 15.8 | 90 | 188.6 | 23.2 | 50 | 248.1 | 30.5 |
| 11 | 10.9 | 1.3 | 71 | 70.5 | 8.7 | 131 | 130.0 | 16.0 | 191 | 189.6 | 23.3 | 251 | 249.1 | 30.6 |
| 12 | 11.9 | 1.5 | 72 | 71.5 | 8.8 | 32 | 131.0 | 16.1 | 92 | 190.6 | 23.4 | 52 | 250.1 | 30.7 |
| 13 | 12.9 | 1.6 | 73 | 72.5 | 8.9 | 33 | 132.0 | 16.2 | 93 | 191.6 | 23.5 | 53 | 251.1 | 30.8 |
| 14 | 13.9 | 1.7 | 74 | 73.4 | 9.0 | 34 | 133.0 | 16.3 | 94 | 192.6 | 23.6 | 54 | 252.1 | 31.0 |
| 15 | 14.9 | 1.8 | 75 | 74.4 | 9.1 | 35 | 134.0 | 16.5 | 95 | 193.5 | 23.8 | 55 | 253.1 | 31.1 |
| 16 | 15.9 | 1.9 | 76 | 75.4 | 9.3 | 36 | 135.0 | 16.6 | 96 | 194.5 | 23.9 | 56 | 254.1 | 31.2 |
| 17 | 16.9 | 2.1 | 77 | 76.4 | 9.4 | 37 | 136.0 | 16.7 | 97 | 195.5 | 24.0 | 57 | 255.1 | 31.3 |
| 18 | 17.9 | 2.2 | 78 | 77.4 | 9.5 | 38 | 137.0 | 16.8 | 98 | 196.5 | 24.1 | 58 | 256.1 | 31.4 |
| 19 | 18.9 | 2.3 | 79 | 78.4 | 9.6 | 39 | 138.0 | 16.9 | 99 | 197.5 | 24.3 | 59 | 257.1 | 31.6 |
| 20 | 19.9 | 2.4 | 80 | 79.4 | 9.7 | 40 | 139.0 | 17.1 | 200 | 198.5 | 24.4 | 60 | 258.1 | 31.7 |
| 21 | 20.8 | 2.6 | 81 | 80.4 | 9.9 | 141 | 139.9 | 17.2 | 201 | 199.5 | 24.5 | 261 | 259.1 | 31.8 |
| 22 | 21.8 | 2.7 | 82 | 81.4 | 10.0 | 42 | 140.9 | 17.3 | 02 | 200.5 | 24.6 | 62 | 260.0 | 31.9 |
| 23 | 22.8 | 2.8 | 83 | 82.4 | 10.1 | 43 | 141.9 | 17.4 | 03 | 201.5 | 24.7 | 63 | 261.0 | 32.1 |
| 24 | 23.8 | 2.9 | 84 | 83.4 | 10.2 | 44 | 142.9 | 17.5 | 04 | 202.5 | 24.9 | 64 | 262.0 | 32.2 |
| 25 | 24.8 | 3.0 | 85 | 84.4 | 10.4 | 45 | 143.9 | 17.7 | 05 | 203.5 | 25.0 | 65 | 263.0 | 32.3 |
| 26 | 25.8 | 3.2 | 86 | 85.4 | 10.5 | 46 | 144.9 | 17.8 | 06 | 204.5 | 25.1 | 66 | 264.0 | 32.4 |
| 27 | 26.8 | 3.3 | 87 | 86.4 | 10.6 | 47 | 145.9 | 17.9 | 07 | 205.5 | 25.2 | 67 | 265.0 | 32.5 |
| 28 | 27.8 | 3.4 | 88 | 87.3 | 10.7 | 48 | 146.9 | 18.0 | 08 | 206.4 | 25.3 | 68 | 266.0 | 32.7 |
| 29 | 28.8 | 3.5 | 89 | 88.3 | 10.8 | 49 | 147.9 | 18.2 | 09 | 207.4 | 25.5 | 69 | 267.0 | 32.8 |
| 30 | 29.8 | 3.7 | 90 | 89.3 | 11.0 | 50 | 148.9 | 18.3 | 10 | 208.4 | 25.6 | 70 | 268.0 | 32.9 |
| 31 | 30.8 | 3.8 | 91 | 90.3 | 11.1 | 151 | 149.9 | 18.4 | 211 | 209.4 | 25.7 | 271 | 269.0 | 33.0 |
| 32 | 31.8 | 3.9 | 92 | 91.3 | 11.2 | 52 | 150.9 | 18.5 | 12 | 210.4 | 25.8 | 72 | 270.0 | 33.1 |
| 33 | 32.8 | 4.0 | 93 | 92.3 | 11.3 | 53 | 151.9 | 18.6 | 13 | 211.4 | 26.0 | 73 | 271.0 | 33.3 |
| 34 | 33.7 | 4.1 | 94 | 93.3 | 11.5 | 54 | 152.9 | 18.8 | 14 | 212.4 | 26.1 | 74 | 272.0 | 33.4 |
| 35 | 34.7 | 4.3 | 95 | 94.3 | 11.6 | 55 | 153.8 | 18.9 | 15 | 213.4 | 26.2 | 75 | 273.0 | 33.5 |
| 36 | 35.7 | 4.4 | 96 | 95.3 | 11.7 | 56 | 154.8 | 19.0 | 16 | 214.4 | 26.3 | 76 | 273.9 | 33.6 |
| 37 | 36.7 | 4.5 | 97 | 96.3 | 11.8 | 57 | 155.8 | 19.1 | 17 | 215.4 | 26.4 | 77 | 274.9 | 33.8 |
| 38 | 37.7 | 4.6 | 98 | 97.3 | 11.9 | 58 | 156.8 | 19.3 | 18 | 216.4 | 26.6 | 78 | 275.9 | 33.9 |
| 39 | 38.7 | 4.8 | 99 | 98.3 | 12.1 | 59 | 157.8 | 19.4 | 19 | 217.4 | 26.7 | 79 | 276.9 | 34.0 |
| 40 | 39.7 | 4.9 | 100 | 99.3 | 12.2 | 60 | 158.8 | 19.5 | 20 | 218.4 | 26.8 | 80 | 277.9 | 34.1 |
| 41 | 40.7 | 5.0 | 101 | 100.2 | 12.3 | 161 | 159.8 | 19.6 | 221 | 219.4 | 26.9 | 281 | 278.9 | 34.2 |
| 42 | 41.7 | 5.1 | 02 | 101.2 | 12.4 | 62 | 160.8 | 19.7 | 22 | 220.3 | 27.1 | 82 | 279.9 | 34.4 |
| 43 | 42.7 | 5.2 | 03 | 102.2 | 12.6 | 63 | 161.8 | 19.9 | 23 | 221.3 | 27.2 | 83 | 280.9 | 34.5 |
| 44 | 43.7 | 5.4 | 04 | 103.2 | 12.7 | 64 | 162.8 | 20.0 | 24 | 222.3 | 27.3 | 84 | 281.9 | 34.6 |
| 45 | 44.7 | 5.5 | 05 | 104.2 | 12.8 | 65 | 163.8 | 20.1 | 25 | 223.3 | 27.4 | 85 | 282.9 | 34.7 |
| 46 | 45.7 | 5.6 | 06 | 105.2 | 12.9 | 66 | 164.8 | 20.2 | 26 | 224.3 | 27.5 | 86 | 283.9 | 34.9 |
| 47 | 46.6 | 5.7 | 07 | 106.2 | 13.0 | 67 | 165.8 | 20.4 | 27 | 225.3 | 27.7 | 87 | 284.9 | 35.0 |
| 48 | 47.6 | 5.8 | 08 | 107.2 | 13.2 | 68 | 166.7 | 20.5 | 28 | 226.3 | 27.8 | 88 | 285.9 | 35.1 |
| 49 | 48.6 | 6.0 | 09 | 108.2 | 13.3 | 69 | 167.7 | 20.6 | 29 | 227.3 | 27.9 | 89 | 286.8 | 35.2 |
| 50 | 49.6 | 6.1 | 10 | 109.2 | 13.4 | 70 | 168.7 | 20.7 | 30 | 228.3 | 28.0 | 90 | 287.8 | 35.3 |
| 51 | 50.6 | 6.2 | 111 | 110.2 | 13.5 | 171 | 169.7 | 20.8 | 231 | 229.3 | 28.2 | 291 | 288.8 | 35.5 |
| 52 | 51.6 | 6.3 | 12 | 111.2 | 13.6 | 72 | 170.7 | 21.0 | 32 | 230.3 | 28.3 | 92 | 289.8 | 35.6 |
| 53 | 52.6 | 6.5 | 13 | 112.2 | 13.8 | 73 | 171.7 | 21.1 | 33 | 231.3 | 28.4 | 93 | 290.8 | 35.7 |
| 54 | 53.6 | 6.6 | 14 | 113.2 | 13.9 | 74 | 172.7 | 21.2 | 34 | 232.3 | 28.5 | 94 | 291.8 | 35.8 |
| 55 | 54.6 | 6.7 | 15 | 114.1 | 14.0 | 75 | 173.7 | 21.3 | 35 | 233.2 | 28.6 | 95 | 292.8 | 36.0 |
| 56 | 55.6 | 6.8 | 16 | 115.1 | 14.1 | 76 | 174.7 | 21.4 | 36 | 234.2 | 28.8 | 96 | 293.8 | 36.1 |
| 57 | 56.6 | 6.9 | 17 | 116.1 | 14.3 | 77 | 175.7 | 21.6 | 37 | 235.2 | 28.9 | 97 | 294.8 | 36.2 |
| 58 | 57.6 | 7.1 | 18 | 117.1 | 14.4 | 78 | 176.7 | 21.7 | 38 | 236.2 | 29.0 | 98 | 295.8 | 36.3 |
| 59 | 58.6 | 7.2 | 19 | 118.1 | 14.5 | 79 | 177.7 | 21.8 | 39 | 237.2 | 29.1 | 99 | 296.8 | 36.4 |
| 60 | 59.6 | 7.3 | 20 | 119.1 | 14.6 | 80 | 178.7 | 21.9 | 40 | 238.2 | 29.2 | 300 | 297.8 | 36.6 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

# TABLE 2. [Page 381

Difference of Latitude and Departure for 7° (173°, 187°, 353°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 298.7 | 36.7 | 361 | 358.3 | 44.0 | 421 | 417.9 | 51.3 | 481 | 477.4 | 58.6 | 541 | 537.0 | 65.9 |
| 02 | 299.7. | 36.8 | 62 | 359.3 | 44.1 | 22 | 418.8 | 51.4 | 82 | 478.4 | 58.7 | 42 | 537.9 | 66.0 |
| 03 | 300.7 | 36.9 | 63 | 360.3 | 44.2 | 23 | 419.8 | 51.5 | 83 | 479.4 | 58.8 | 43 | 538.9 | 66.2 |
| 04 | 301.7 | 37.0 | 64 | 361.3 | 44.4 | 24 | 420.8 | 51.7 | 84 | 480.4 | 59.0 | 44 | 539.9 | 66.3 |
| 05 | 302.7 | 37.2 | 65 | 362.3 | 44.5 | 25 | 421.8 | 51.8 | 85 | 481.4 | 59.1 | 45 | 540.9 | 66.4 |
| 06 | 303.7 | 37.3 | 66 | 363.3 | 44.6 | 26 | 422.8 | 51.9 | 86 | 482.4 | 59.2 | 46 | 541.9 | 66.6 |
| 07 | 304.7 | 37.4 | 67 | 364.3 | 44.7 | 27 | 423.8 | 52.0 | 87 | 483.4 | 59.4 | 47 | 542.9 | 66.7 |
| 08 | 305.7 | 37.5 | 68 | 365.2 | 44.8 | 28 | 424.8 | 52.2 | 88 | 484.3 | 59.5 | 48 | 543.9 | 66.8 |
| 09 | 306.7 | 37.7 | 69 | 366.2 | 45.0 | 29 | 425.8 | 52.3 | 89 | 485.3 | 59.6 | 49 | 544.9 | 66.9 |
| 10 | 307.7 | 37.8 | 70 | 367.2 | 45.1 | 30 | 426.8 | 52.4 | 90 | 486.3 | 59.7 | 50 | 545.9 | 67.0 |
| 311 | 308.7 | 37.9 | 371 | 368.2 | 45.2 | 431 | 427.8 | 52.5 | 491 | 487.3 | 59.8 | 551 | 546.9 | 67.1 |
| 12 | 309.7 | 38.0 | 72 | 369.2 | 45.3 | 32 | 428.8 | 52.6 | 92 | 488.3 | 59.9 | 52 | 547.9 | 67.2 |
| 13 | 310.7 | 38.1 | 73 | 370.2 | 45.5 | 33 | 429.8 | 52.8 | 93 | 489.3 | 60.1 | 53 | 548.9 | 67.4 |
| 14 | 311.7 | 38.3 | 74 | 371.2 | 45.6 | 34 | 430.8 | 52.9 | 94 | 490.3 | 60.2 | 54 | 549.9 | 67.5 |
| 15 | 312.6 | 38.4 | 75 | 372.2 | 45.7 | 35 | 431.7 | 53.0 | 95 | 491.3 | 60.3 | 55 | 550.8 | 67.6 |
| 16 | 313.6 | 38.5 | 76 | 373.2 | 45.8 | 36 | 432.7 | 53.1 | 96 | 492.3 | 60.5 | 56 | 551.8 | 67.8 |
| 17 | 314.6 | 38.6 | 77 | 374.2 | 45.9 | 37 | 433.7 | 53.3 | 97 | 493.3 | 60.6 | 57 | 552.8 | 67.9 |
| 18 | 315.6 | 38.7 | 78 | 375.2 | 46.1 | 38 | 434.7 | 53.4 | 98 | 494.3 | 60.7 | 58 | 553.8 | 68.0 |
| 19 | 316.6 | 38.9 | 79 | 376.2 | 46.2 | 39 | 435.7 | 53.5 | 99 | 495.3 | 60.8 | 59 | 554.8 | 68.1 |
| 20 | 317.6 | 39.0 | 80 | 377.2 | 46.3 | 40 | 436.7 | 53.6 | 500 | 496.3 | 61.0 | 60 | 555.8 | 68.3 |
| 321 | 318.6 | 39.1 | 381 | 378.1 | 46.4 | 441 | 437.7 | 53.7 | 501 | 497.2 | 61.1 | 561 | 556.8 | 68.4 |
| 22 | 319.6 | 39.2 | 82 | 379.1 | 46.5 | 42 | 438.7 | 53.9 | 02 | 498.2 | 61.2 | 62 | 557.8 | 68.5 |
| 23 | 320.6 | 39.4 | 83 | 380.1 | 46.7 | 43 | 439.7 | 54.0 | 03 | 499.2 | 61.3 | 63 | 558.8 | 68.6 |
| 24 | 321.6 | 39.5 | 84 | 381.1 | 46.8 | 44 | 440.7 | 54.1 | 04 | 500.2 | 61.4 | 64 | 559.8 | 68.7 |
| 25 | 322.6 | 39.6 | 85 | 382.1 | 46.9 | 45 | 441.7 | 54.2 | 05 | 501.2 | 61.5 | 65 | 560.8 | 68.9 |
| 26 | 323.6 | 39.7 | 86 | 383.1 | 47.0 | 46 | 442.7 | 54.3 | 06 | 502.2 | 61.6 | 66 | 561.8 | 69.0 |
| 27 | 324.6 | 39.8 | 87 | 384.1 | 47.2 | 47 | 443.7 | 54.5 | 07 | 503.2 | 61.8 | 67 | 562.8 | 69.1 |
| 28 | 325.5 | 40.0 | 88 | 385.1 | 47.3 | 48 | 444.7 | 54.6 | 08 | 504.2 | 61.9 | 68 | 563.8 | 69.2 |
| 29 | 326.5 | 40.1 | 89 | 386.1 | 47.4 | 49 | 445.6 | 54.7 | 09 | 505.2 | 62.0 | 69 | 564.8 | 69.3 |
| 30 | 327.5 | 40.2 | 90 | 387.1 | 47.5 | 50 | 446.6 | 54.8 | 10 | 506.2 | 62.1 | 70 | 565.8 | 69.4 |
| 331 | 328.5 | 40.3 | 391 | 388.1 | 47.6 | 451 | 447.6 | 55.0 | 511 | 507.2 | 62.3 | 571 | 566.7 | 69.6 |
| 32 | 329.5 | 40.5 | 92 | 389.1 | 47.8 | 52 | 448.6 | 55.1 | 12 | 508.2 | 62.4 | 72 | 567.7 | 69.7 |
| 33 | 330.5 | 40.6 | 93 | 390.1 | 47.9 | 53 | 449.6 | 55.2 | 13 | 509.2 | 62.5 | 73 | 568.7 | 69.8 |
| 34 | 331.5 | 40.7 | 94 | 391.1 | 48.0 | 54 | 450.6 | 55.3 | 14 | 510.2 | 62.6 | 74 | 569.7 | 69.9 |
| 35 | 332.5 | 40.8 | 95 | 392.0 | 48.1 | 55 | 451.6 | 55.4 | 15 | 511.1 | 62.7 | 75 | 570.7 | 70.1 |
| 36 | 333.5 | 40.9 | 96 | 393.0 | 48.3 | 56 | 452.6 | 55.6 | 16 | 512.1 | 62.9 | 76 | 571.7 | 70.2 |
| 37 | 334.5 | 41.1 | 97 | 394.0 | 48.4 | 57 | 453.6 | 55.7 | 17 | 513.1 | 63.0 | 77 | 572.7 | 70.3 |
| 38 | 335.5 | 41.2 | 98 | 395.0 | 48.5 | 58 | 454.6 | 55.8 | 18 | 514.1 | 63.1 | 78 | 573.7 | 70.4 |
| 39 | 336.5 | 41.3 | 99 | 396.0 | 48.6 | 59 | 455.6 | 55.9 | 19 | 515.1 | 63.2 | 79 | 574.7 | 70.5 |
| 40 | 337.5 | 41.4 | 400 | 397.0 | 48.7 | 60 | 456.6 | 56.1 | 20 | 516.1 | 63.4 | 80 | 575.7 | 70.7 |
| 341 | 338.4 | 41.6 | 401 | 398.0 | 48.9 | 461 | 457.6 | 56.2 | 521 | 517.1 | 63.5 | 581 | 576.7 | 70.8 |
| 42 | 339.4 | 41.7 | 02 | 399.0 | 49.0 | 62 | 458.5 | 56.3 | 22 | 518.1 | 63.6 | 82 | 577.6 | 70.9 |
| 43 | 340.4 | 41.8 | 03 | 400.0 | 49.1 | 63 | 459.5 | 56.4 | 23 | 519.1 | 63.7 | 83 | 578.6 | 71.0 |
| 44 | 341.4 | 41.9 | 04 | 401.0 | 49.2 | 64 | 460.5 | 56.5 | 24 | 520.1 | 63.8 | 84 | 579.6 | 71.2 |
| 45 | 342.4 | 42.0 | 05 | 402.0 | 49.4 | 65 | 461.5 | 56.7 | 25 | 521.1 | 64.0 | 85 | 580.6 | 71.3 |
| 46 | 343.4 | 42.2 | 06 | 403.0 | 49.5 | 66 | 462.5 | 56.8 | 26 | 522.1 | 64.1 | 86 | 581.6 | 71.4 |
| 47 | 344.4 | 42.3 | 07 | 404.0 | 49.6 | 67 | 463.5 | 56.9 | 27 | 523.1 | 64.2 | 87 | 582.6 | 71.5 |
| 48 | 345.4 | 42.4 | 08 | 405.0 | 49.7 | 68 | 464.5 | 57.0 | 28 | 524.1 | 64.3 | 88 | 583.6 | 71.6 |
| 49 | 346.4 | 42.5 | 09 | 405.9 | 49.8 | 69 | 465.5 | 57.2 | 29 | 525.0 | 64.5 | 89 | 584.6 | 71.8 |
| 50 | 347.4 | 42.6 | 10 | 406.9 | 50.0 | 70 | 466.5 | 57.3 | 30 | 526.0 | 64.6 | 90 | 585.6 | 71.9 |
| 351 | 348.4 | 42.8 | 411 | 407.9 | 50.1 | 471 | 467.5 | 57.4 | 531 | 527.0 | 64.7 | 591 | 586.6 | 72.0 |
| 52 | 349.4 | 42.9 | 12 | 408.9 | 50.2 | 72 | 468.5 | 57.5 | 32 | 528.0 | 64.8 | 92 | 587.6 | 72.1 |
| 53 | 350.4 | 43.0 | 13 | 409.9 | 50.3 | 73 | 469.5 | 57.6 | 33 | 529.0 | 64.9 | 93 | 588.6 | 72.2 |
| 54 | 351.4 | 43.1 | 14 | 410.9 | 50.4 | 74 | 470.5 | 57.8 | 34 | 530.0 | 65.1 | 94 | 589.6 | 72.4 |
| 55 | 352.3 | 43.3 | 15 | 411.9 | 50.6 | 75 | 471.5 | 57.9 | 35 | 531.0 | 65.2 | 95 | 590.6 | 72.5 |
| 56 | 353.3 | 43.4 | 16 | 412.9 | 50.7 | 76 | 472.4 | 58.0 | 36 | 532.0 | 65.3 | 96 | 591.5 | 72.6 |
| 57 | 354.3 | 43.5 | 17 | 413.9 | 50.8 | 77 | 473.4 | 58.1 | 37 | 533.0 | 65.4 | 97 | 592.5 | 72.7 |
| 58 | 355.3 | 43.6 | 18 | 414.9 | 50.9 | 78 | 474.4 | 58.2 | 38 | 534.0 | 65.6 | 98 | 593.5 | 72.9 |
| 59 | 356.3 | 43.7 | 19 | 415.9 | 51.1 | 79 | 475.4 | 58.4 | 39 | 535.0 | 65.7 | 99 | 594.5 | 73.0 |
| 60 | 357.3 | 43.9 | 20 | 416.9 | 51.2 | 80 | 476.4 | 58.5 | 40 | 536.0 | 65.8 | 600 | 595.5 | 73.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

83° (97°, 263°, 277°).

## TABLE 2.

Difference of Latitude and Departure for 8° (172°, 188°, 352°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.1 | 61 | 60.4 | 8.5 | 121 | 119.8 | 16.8 | 181 | 179.2 | 25.2 | 241 | 238.7 | 33.5 | | | |
| 2 | 2.0 | 0.3 | 62 | 61.4 | 8.6 | 22 | 120.8 | 17.0 | 82 | 180.2 | 25.3 | 42 | 239.6 | 33.7 | | | |
| 3 | 3.0 | 0.4 | 63 | 62.4 | 8.8 | 23 | 121.8 | 17.1 | 83 | 181.2 | 25.5 | 43 | 240.6 | 33.8 | | | |
| 4 | 4.0 | 0.6 | 64 | 63.4 | 8.9 | 24 | 122.8 | 17.3 | 84 | 182.2 | 25.6 | 44 | 241.6 | 34.0 | | | |
| 5 | 5.0 | 0.7 | 65 | 64.4 | 9.0 | 25 | 123.8 | 17.4 | 85 | 183.2 | 25.7 | 45 | 242.6 | 34.1 | | | |
| 6 | 5.9 | 0.8 | 66 | 65.4 | 9.2 | 26 | 124.8 | 17.5 | 86 | 184.2 | 25.9 | 46 | 243.6 | 34.2 | | | |
| 7 | 6.9 | 1.0 | 67 | 66.3 | 9.3 | 27 | 125.8 | 17.7 | 87 | 185.2 | 26.0 | 47 | 244.6 | 34.4 | | | |
| 8 | 7.9 | 1.1 | 68 | 67.3 | 9.5 | 28 | 126.8 | 17.8 | 88 | 186.2 | 26.2 | 48 | 245.6 | 34.5 | | | |
| 9 | 8.9 | 1.3 | 69 | 68.3 | 9.6 | 29 | 127.7 | 18.0 | 89 | 187.2 | 26.3 | 49 | 246.6 | 34.7 | | | |
| 10 | 9.9 | 1.4 | 70 | 69.3 | 9.7 | 30 | 128.7 | 18.1 | 90 | 188.2 | 26.4 | 50 | 247.6 | 34.8 | | | |
| 11 | 10.9 | 1.5 | 71 | 70.3 | 9.9 | 131 | 129.7 | 18.2 | 191 | 189.1 | 26.6 | 251 | 248.6 | 34.9 | | | |
| 12 | 11.9 | 1.7 | 72 | 71.3 | 10.0 | 32 | 130.7 | 18.4 | 92 | 190.1 | 26.7 | 52 | 249.5 | 35.1 | | | |
| 13 | 12.9 | 1.8 | 73 | 72.3 | 10.2 | 33 | 131.7 | 18.5 | 93 | 191.1 | 26.9 | 53 | 250.5 | 35.2 | | | |
| 14 | 13.9 | 1.9 | 74 | 73.3 | 10.3 | 34 | 132.7 | 18.6 | 94 | 192.1 | 27.0 | 54 | 251.5 | 35.3 | | | |
| 15 | 14.9 | 2.1 | 75 | 74.3 | 10.4 | 35 | 133.7 | 18.8 | 95 | 193.1 | 27.1 | 55 | 252.5 | 35.5 | | | |
| 16 | 15.8 | 2.2 | 76 | 75.3 | 10.6 | 36 | 134.7 | 18.9 | 96 | 194.1 | 27.3 | 56 | 253.5 | 35.6 | | | |
| 17 | 16.8 | 2.4 | 77 | 76.3 | 10.7 | 37 | 135.7 | 19.1 | 97 | 195.1 | 27.4 | 57 | 254.5 | 35.8 | | | |
| 18 | 17.8 | 2.5 | 78 | 77.2 | 10.9 | 38 | 136.7 | 19.2 | 98 | 196.1 | 27.6 | 58 | 255.5 | 35.9 | | | |
| 19 | 18.8 | 2.6 | 79 | 78.2 | 11.0 | 39 | 137.7 | 19.3 | 99 | 197.1 | 27.7 | 59 | 256.5 | 36.0 | | | |
| 20 | 19.8 | 2.8 | 80 | 79.2 | 11.1 | 40 | 138.6 | 19.5 | 200 | 198.1 | 27.8 | 60 | 257.5 | 36.2 | | | |
| 21 | 20.8 | 2.9 | 81 | 80.2 | 11.3 | 141 | 139.6 | 19.6 | 201 | 199.0 | 28.0 | 261 | 258.5 | 36.3 | | | |
| 22 | 21.8 | 3.1 | 82 | 81.2 | 11.4 | 42 | 140.6 | 19.8 | 02 | 200.0 | 28.1 | 62 | 259.5 | 36.5 | | | |
| 23 | 22.8 | 3.2 | 83 | 82.2 | 11.6 | 43 | 141.6 | 19.9 | 03 | 201.0 | 28.3 | 63 | 260.4 | 36.6 | | | |
| 24 | 23.8 | 3.3 | 84 | 83.2 | 11.7 | 44 | 142.6 | 20.0 | 04 | 202.0 | 28.4 | 64 | 261.4 | 36.7 | | | |
| 25 | 24.8 | 3.5 | 85 | 84.2 | 11.8 | 45 | 143.6 | 20.2 | 05 | 203.0 | 28.5 | 65 | 262.4 | 36.9 | | | |
| 26 | 25.7 | 3.6 | 86 | 85.2 | 12.0 | 46 | 144.6 | 20.3 | 06 | 204.0 | 28.7 | 66 | 263.4 | 37.0 | | | |
| 27 | 26.7 | 3.8 | 87 | 86.2 | 12.1 | 47 | 145.6 | 20.5 | 07 | 205.0 | 28.8 | 67 | 264.4 | 37.2 | | | |
| 28 | 27.7 | 3.9 | 88 | 87.1 | 12.2 | 48 | 146.6 | 20.6 | 08 | 206.0 | 28.9 | 68 | 265.4 | 37.3 | | | |
| 29 | 28.7 | 4.0 | 89 | 88.1 | 12.4 | 49 | 147.5 | 20.7 | 09 | 207.0 | 29.1 | 69 | 266.4 | 37.4 | | | |
| 30 | 29.7 | 4.2 | 90 | 89.1 | 12.5 | 50 | 148.5 | 20.9 | 10 | 208.0 | 29.2 | 70 | 267.4 | 37.6 | | | |
| 31 | 30.7 | 4.3 | 91 | 90.1 | 12.7 | 151 | 149.5 | 21.0 | 211 | 208.9 | 29.4 | 271 | 268.4 | 37.7 | | | |
| 32 | 31.7 | 4.5 | 92 | 91.1 | 12.8 | 52 | 150.5 | 21.2 | 12 | 209.9 | 29.5 | 72 | 269.4 | 37.9 | | | |
| 33 | 32.7 | 4.6 | 93 | 92.1 | 12.9 | 53 | 151.5 | 21.3 | 13 | 210.9 | 29.6 | 73 | 270.3 | 38.0 | | | |
| 34 | 33.7 | 4.7 | 94 | 93.1 | 13.1 | 54 | 152.5 | 21.4 | 14 | 211.9 | 29.8 | 74 | 271.3 | 38.1 | | | |
| 35 | 34.7 | 4.9 | 95 | 94.1 | 13.2 | 55 | 153.5 | 21.6 | 15 | 212.9 | 29.9 | 75 | 272.3 | 38.3 | | | |
| 36 | 35.6 | 5.0 | 96 | 95.1 | 13.4 | 56 | 154.5 | 21.7 | 16 | 213.9 | 30.1 | 76 | 273.3 | 38.4 | | | |
| 37 | 36.6 | 5.1 | 97 | 96.1 | 13.5 | 57 | 155.5 | 21.9 | 17 | 214.9 | 30.2 | 77 | 274.3 | 38.6 | | | |
| 38 | 37.6 | 5.3 | 98 | 97.0 | 13.6 | 58 | 156.5 | 22.0 | 18 | 215.9 | 30.3 | 78 | 275.3 | 38.7 | | | |
| 39 | 38.6 | 5.4 | 99 | 98.0 | 13.8 | 59 | 157.5 | 22.1 | .19 | 216.9 | 30.5 | 79 | 276.3 | 38.8 | | | |
| 40 | 39.6 | 5.6 | 100 | 99.0 | 13.9 | 60 | 158.4 | 22.3 | 20 | 217.9 | 30.6 | 80 | 277.3 | 39.0 | | | |
| 41 | 40.6 | 5.7 | 101 | 100.0 | 14.1 | 161 | 159.4 | 22.4 | 221 | 218.8 | 30.8 | 281 | 278.3 | 39.1 | | | |
| 42 | 41.6 | 5.8 | 02 | 101.0 | 14.2 | 62 | 160.4 | 22.5 | 22 | 219.8 | 30.9 | 82 | 279.3 | 39.2 | | | |
| 43 | 42.6 | 6.0 | 03 | 102.0 | 14.3 | 63 | 161.4 | 22.7 | 23 | 220.8 | 31.0 | 83 | 280.2 | 39.4 | | | |
| 44 | 43.6 | 6.1 | 04 | 103.0 | 14.5 | 64 | 162.4 | 22.8 | 24 | 221.8 | 31.2 | 84 | 281.2 | 39.5 | | | |
| 45 | 44.6 | 6.3 | 05 | 104.0 | 14.6 | 65 | 163.4 | 23.0 | 25 | 222.8 | 31.3 | 85 | 282.2 | 39.7 | | | |
| 46 | 45.6 | 6.4 | 06 | 105.0 | 14.8 | 66 | 164.4 | 23.1 | 26 | 223.8 | 31.5 | 86 | 283.2 | 39.8 | | | |
| 47 | 46.5 | 6.5 | 07 | 106.0 | 14.9 | 67 | 165.4 | 23.2 | 27 | 224.8 | 31.6 | 87 | 284.2 | 39.9 | | | |
| 48 | 47.5 | 6.7 | 08 | 106.9 | 15.0 | 68 | 166.4 | 23.4 | 28 | 225.8 | 31.7 | 88 | 285.2 | 40.1 | | | |
| 49 | 48.5 | 6.8 | 09 | 107.9 | 15.2 | 69 | 167.4 | 23.5 | 29 | 226.8 | 31.9 | 89 | 286.2 | 40.2 | | | |
| 50 | 49.5 | 7.0 | 10 | 108.9 | 15.3 | 70 | 168.3 | 23.7 | 30 | 227.8 | 32.0 | 90 | 287.2 | 40.4 | | | |
| 51 | 50.5 | 7.1 | 111 | 109.9 | 15.4 | 171 | 169.3 | 23.8 | 231 | 228.8 | 32.1 | 291 | 288.2 | 40.5 | | | |
| 52 | 51.5 | 7.2 | 12 | 110.9 | 15.6 | 72 | 170.3 | 23.9 | 32 | 229.7 | 32.3 | 92 | 289.2 | 40.6 | | | |
| 53 | 52.5 | 7.4 | 13 | 111.9 | 15.7 | 73 | 171.3 | 24.1 | 33 | 230.7 | 32.4 | 93 | 290.1 | 40.8 | | | |
| 54 | 53.5 | 7.5 | 14 | 112.9 | 15.9 | 74 | 172.3 | 24.2 | 34 | 231.7 | 32.6 | 94 | 291.1 | 40.9 | | | |
| 55 | 54.5 | 7.7 | 15 | 113.9 | 16.0 | 75 | 173.3 | 24.4 | 35 | 232.7 | 32.7 | 95 | 292.1 | 41.1 | | | |
| 56 | 55.5 | 7.8 | 16 | 114.9 | 16.1 | 76 | 174.3 | 24.5 | 36 | 233.7 | 32.8 | 96 | 293.1 | 41.2 | | | |
| 57 | 56.4 | 7.9 | 17 | 115.9 | 16.3 | 77 | 175.3 | 24.6 | 37 | 234.7 | 33.0 | 97 | 294.1 | 41.3 | | | |
| 58 | 57.4 | 8.1 | 18 | 116.9 | 16.4 | 78 | 176.3 | 24.8 | 38 | 235.7 | 33.1 | 98 | 295.1 | 41.5 | | | |
| 59 | 58.4 | 8.2 | 19 | 117.8 | 16.6 | 79 | 177.3 | 24.9 | 39 | 236.7 | 33.3 | 99 | 296.1 | 41.6 | | | |
| 60 | 59.4 | 8.4 | 20 | 118.8 | 16.7 | 80 | 178.2 | 25.1 | 40 | 237.7 | 33.4 | 300 | 297.1 | 41.8 | | | |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | | | |

82° (98°, 262°, 278°).

TABLE 2. [Page 383

Difference of Latitude and Departure for 8° (172°, 188°, 352°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 298.0 | 41.9 | 361 | 357.5 | 50.2 | 421 | 416.9 | 58.6 | 481 | 476.3 | 66.9 | 541 | 535.7 | 75.2 |
| 02 | 299.0 | 42.0 | 62 | 358.5 | 50.4 | 22 | 417.9 | 58.7 | 82 | 477.3 | 67.1 | 42 | 536.7 | 75.4 |
| 03 | 300.0 | 42.2 | 63 | 359.4 | 50.5 | 23 | 418.9 | 58.9 | 83 | 478.3 | 67.2 | 43 | 537.7 | 75.5 |
| 04 | 301.0 | 42.3 | 64 | 360.4 | 50.7 | 24 | 419.8 | 59.0 | 84 | 479.3 | 67.4 | 44 | 538.7 | 75.7 |
| 05 | 302.0 | 42.5 | 65 | 361.4 | 50.8 | 25 | 420.8 | 59.2 | 85 | 480.3 | 67.5 | 45 | 539.7 | 75.8 |
| 06 | 303.0 | 42.6 | 66 | 362.4 | 50.9 | 26 | 421.8 | 59.3 | 86 | 481.2 | 67.6 | 46 | 540.6 | 75.9 |
| 07 | 304.0 | 42.7 | 67 | 363.4 | 51.1 | 27 | 422.8 | 59.4 | 87 | 482.2 | 67.8 | 47 | 541.6 | 76.1 |
| 08 | 305.0 | 42.9 | 68 | 364.4 | 51.2 | 28 | 423.8 | 59.6 | 88 | 483.2 | 67.9 | 48 | 542.6 | 76.2 |
| 09 | 306.0 | 43.0 | 69 | 365.4 | 51.4 | 29 | 424.8 | 59.7 | 89 | 484.2 | 68.1 | 49 | 543.6 | 76.4 |
| 10 | 307.0 | 43.1 | 70 | 366.4 | 51.5 | 30 | 425.8 | 59.8 | 90 | 485.2 | 68.2 | 50 | 544.6 | 76.5 |
| 311 | 307.9 | 43.3 | 371 | 367.4 | 51.6 | 431 | 426.8 | 60.0 | 491 | 486.2 | 68.3 | 551 | 545.6 | 76.6 |
| 12 | 308.9 | 43.4 | 72 | 368.4 | 51.8 | 32 | 427.8 | 60.1 | 92 | 487.2 | 68.5 | 52 | 546.6 | 76.8 |
| 13 | 309.9 | 43.6 | 73 | 369.3 | 51.9 | 33 | 428.8 | 60.3 | 93 | 488.2 | 68.6 | 53 | 547.6 | 76.9 |
| 14 | 310.9 | 43.7 | 74 | 370.3 | 52.1 | 34 | 429.8 | 60.4 | 94 | 489.2 | 68.8 | 54 | 548.6 | 77.1 |
| 15 | 311.9 | 43.8 | 75 | 371.3 | 52.2 | 35 | 430.7 | 60.5 | 95 | 490.2 | 68.9 | 55 | 549.6 | 77.2 |
| 16 | 312.9 | 44.0 | 76 | 372.3 | 52.3 | 36 | 431.7 | 60.7 | 96 | 491.2 | 69.0 | 56 | 550.6 | 77.4 |
| 17 | 313.9 | 44.1 | 77 | 373.3 | 52.5 | 37 | 432.7 | 60.8 | 97 | 492.1 | 69.2 | 57 | 551.5 | 77.5 |
| 18 | 314.9 | 44.3 | 78 | 374.3 | 52.6 | 38 | 433.7 | 61.0 | 98 | 493.1 | 69.3 | 58 | 552.5 | 77.6 |
| 19 | 315.9 | 44.4 | 79 | 375.3 | 52.7 | 39 | 434.7 | 61.1 | 99 | 494.1 | 69.5 | 59 | 553.5 | 77.8 |
| 20 | 316.9 | 44.5 | 80 | 376.3 | 52.9 | 40 | 435.7 | 61.2 | 500 | 495.1 | 69.6 | 60 | 554.5 | 77.9 |
| 321 | 317.9 | 44.7 | 381 | 377.3 | 53.0 | 441 | 436.7 | 61.4 | 501 | 496.1 | 69.7 | 561 | 555.5 | 78.1 |
| 22 | 318.8 | 44.8 | 82 | 378.3 | 53.2 | 42 | 437.7 | 61.5 | 02 | 497.1 | 69.9 | 62 | 556.5 | 78.2 |
| 23 | 319.8 | 45.0 | 83 | 379.2 | 53.3 | 43 | 438.7 | 61.7 | 03 | 498.1 | 70.0 | 63 | 557.5 | 78.3 |
| 24 | 320.8 | 45.1 | 84 | 380.2 | 53.4 | 44 | 439.7 | 61.8 | 04 | 499.1 | 70.2 | 64 | 558.5 | 78.5 |
| 25 | 321.8 | 45.2 | 85 | 381.2 | 53.6 | 45 | 440.6 | 61.9 | 05 | 500.1 | 70.3 | 65 | 559.5 | 78.6 |
| 26 | 322.8 | 45.4 | 86 | 382.2 | 53.7 | 46 | 441.6 | 62.1 | 06 | 501.0 | 70.4 | 66 | 560.5 | 78.8 |
| 27 | 323.8 | 45.5 | 87 | 383.2 | 53.9 | 47 | 442.6 | 62.2 | 07 | 502.0 | 70.6 | 67 | 561.5 | 78.9 |
| 28 | 324.8 | 45.7 | 88 | 384.2 | 54.0 | 48 | 443.6 | 62.4 | 08 | 503.0 | 70.7 | 68 | 562.5 | 79.0 |
| 29 | 325.8 | 45.8 | 89 | 385.2 | 54.1 | 49 | 444.6 | 62.5 | 09 | 504.0 | 70.8 | 69 | 563.5 | 79.1 |
| 30 | 326.8 | 45.9 | 90 | 386.2 | 54.3 | 50 | 445.6 | 62.6 | 10 | 505.0 | 70.9 | 70 | 564.5 | 79.3 |
| 331 | 327.8 | 46.1 | 391 | 387.2 | 54.4 | 451 | 446.6 | 62.8 | 511 | 506.0 | 71.1 | 571 | 565.4 | 79.4 |
| 32 | 328.7 | 46.2 | 92 | 388.2 | 54.6 | 52 | 447.6 | 62.9 | 12 | 507.0 | 71.2 | 72 | 566.4 | 79.6 |
| 33 | 329.7 | 46.3 | 93 | 389.1 | 54.7 | 53 | 448.6 | 63.0 | 13 | 508.0 | 71.4 | 73 | 567.4 | 79.7 |
| 34 | 330.7 | 46.5 | 94 | 390.1 | 54.8 | 54 | 449.6 | 63.2 | 14 | 509.0 | 71.5 | 74 | 568.4 | 79.8 |
| 35 | 331.7 | 46.6 | 95 | 391.1 | 55.0 | 55 | 450.5 | 63.3 | 15 | 510.0 | 71.6 | 75 | 569.4 | 80.0 |
| 36 | 332.7 | 46.8 | 96 | 392.1 | 55.1 | 56 | 451.5 | 63.5 | 16 | 510.9 | 71.8 | 76 | 570.4 | 80.1 |
| 37 | 333.7 | 46.9 | 97 | 393.1 | 55.3 | 57 | 452.5 | 63.6 | 17 | 511.9 | 71.9 | 77 | 571.4 | 80.2 |
| 38 | 334.7 | 47.0 | 98 | 394.1 | 55.4 | 58 | 453.5 | 63.7 | 18 | 512.9 | 72.0 | 78 | 572.4 | 80.4 |
| 39 | 335.7 | 47.2 | 99 | 395.1 | 55.5 | 59 | 454.5 | 63.9 | 19 | 513.9 | 72.2 | 79 | 573.4 | 80.5 |
| 40 | 336.7 | 47.3 | 400 | 396.1 | 55.7 | 60 | 455.5 | 64.0 | 20 | 514.9 | 72.3 | 80 | 574.4 | 80.6 |
| 341 | 337.7 | 47.5 | 401 | 397.1 | 55.8 | 461 | 456.5 | 64.2 | 521 | 515.9 | 72.4 | 581 | 575.4 | 80.8 |
| 42 | 338.6 | 47.6 | 02 | 398.1 | 56.0 | 62 | 457.5 | 64.3 | 22 | 516.9 | 72.6 | 82 | 576.4 | 80.9 |
| 43 | 339.6 | 47.7 | 03 | 399.1 | 56.1 | 63 | 458.5 | 64.4 | 23 | 517.9 | 72.8 | 83 | 577.4 | 81.1 |
| 44 | 340.6 | 47.9 | 04 | 400.0 | 56.2 | 64 | 459.5 | 64.6 | 24 | 518.9 | 73.0 | 84 | 578.4 | 81.3 |
| 45 | 341.6 | 48.0 | 05 | 401.0 | 56.4 | 65 | 460.4 | 64.7 | 25 | 519.9 | 73.1 | 85 | 579.4 | 81.4 |
| 46 | 342.6 | 48.2 | 06 | 402.0 | 56.5 | 66 | 461.4 | 64.9 | 26 | 520.9 | 73.2 | 86 | 580.3 | 81.6 |
| 47 | 343.6 | 48.3 | 07 | 403.0 | 56.6 | 67 | 462.4 | 65.0 | 27 | 521.8 | 73.4 | 87 | 581.3 | 81.7 |
| 48 | 344.6 | 48.4 | 08 | 404.0 | 56.8 | 68 | 463.4 | 65.1 | 28 | 522.8 | 73.5 | 88 | 582.3 | 81.8 |
| 49 | 345.6 | 48.6 | 09 | 405.0 | 56.9 | 69 | 464.4 | 65.3 | 29 | 523.8 | 73.7 | 89 | 583.3 | 82.0 |
| 50 | 346.6 | 48.7 | 10 | 406.0 | 57.1 | 70 | 465.4 | 65.4 | 30 | 524.8 | 73.8 | 90 | 584.3 | 82.1 |
| 351 | 347.6 | 48.9 | 411 | 407.0 | 57.2 | 471 | 466.4 | 65.6 | 531 | 525.8 | 73.9 | 591 | 585.3 | 82.2 |
| 52 | 348.5 | 49.0 | 12 | 408.0 | 57.3 | 72 | 467.4 | 65.7 | 32 | 526.8 | 74.1 | 92 | 586.3 | 82.4 |
| 53 | 349.5 | 49.1 | 13 | 409.0 | 57.5 | 73 | 468.4 | 65.8 | 33 | 527.8 | 74.2 | 93 | 587.3 | 82.5 |
| 54 | 350.5 | 49.3 | 14 | 409.9 | 57.6 | 74 | 469.4 | 66.0 | 34 | 528.8 | 74.3 | 94 | 588.3 | 82.6 |
| 55 | 351.5 | 49.4 | 15 | 410.9 | 57.8 | 75 | 470.4 | 66.1 | 35 | 529.8 | 74.5 | 95 | 589.3 | 82.8 |
| 56 | 352.5 | 49.5 | 16 | 411.9 | 57.9 | 76 | 471.3 | 66.2 | 36 | 530.8 | 74.6 | 96 | 590.3 | 83.0 |
| 57 | 353.5 | 49.7 | 17 | 412.9 | 58.0 | 77 | 472.3 | 66.4 | 37 | 531.7 | 74.7 | 97 | 591.2 | 83.1 |
| 58 | 354.5 | 49.8 | 18 | 413.9 | 58.2 | 78 | 473.3 | 66.5 | 38 | 532.7 | 74.9 | 98 | 592.2 | 83.2 |
| 59 | 355.5 | 50.0 | 19 | 414.9 | 58.3 | 79 | 474.3 | 66.7 | 39 | 533.7 | 75.0 | 99 | 593.2 | 83.3 |
| 60 | 356.5 | 50.1 | 20 | 415.9 | 58.5 | 80 | 475.3 | 66.8 | 40 | 534.7 | 75.1 | 600 | 594.2 | 83.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

82° (98°, 262°, 278°).

# TABLE 2.

Difference of Latitude and Departure for 9° (171°, 189°, 351°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 60.2 | 9.5 | 121 | 119.5 | 18.9 | 181 | 178.8 | 28.3 | 241 | 238.0 | 37.7 |
| 2 | 2.0 | 0.3 | 62 | 61.2 | 9.7 | 22 | 120.5 | 19.1 | 82 | 179.8 | 28.5 | 42 | 239.0 | 37.9 |
| 3 | 3.0 | 0.5 | 63 | 62.2 | 9.9 | 23 | 121.5 | 19.2 | 83 | 180.7 | 28.6 | 43 | 240.0 | 38.0 |
| 4 | 4.0 | 0.6 | 64 | 63.2 | 10.0 | 24 | 122.5 | 19.4 | 84 | 181.7 | 28.8 | 44 | 241.0 | 38.2 |
| 5 | 4.9 | 0.8 | 65 | 64.2 | 10.2 | 25 | 123.5 | 19.6 | 85 | 182.7 | 28.9 | 45 | 242.0 | 38.3 |
| 6 | 5.9 | 0.9 | 66 | 65.2 | 10.3 | 26 | 124.4 | 19.7 | 86 | 183.7 | 29.1 | 46 | 243.0 | 38.5 |
| 7 | 6.9 | 1.1 | 67 | 66.2 | 10.5 | 27 | 125.4 | 19.9 | 87 | 184.7 | 29.3 | 47 | 244.0 | 38.6 |
| 8 | 7.9 | 1.3 | 68 | 67.2 | 10.6 | 28 | 126.4 | 20.0 | 88 | 185.7 | 29.4 | 48 | 244.9 | 38.8 |
| 9 | 8.9 | 1.4 | 69 | 68.2 | 10.8 | 29 | 127.4 | 20.2 | 89 | 186.7 | 29.6 | 49 | 245.9 | 39.0 |
| 10 | 9.9 | 1.6 | 70 | 69.1 | 11.0 | 30 | 128.4 | 20.3 | 90 | 187.7 | 29.7 | 50 | 246.9 | 39.1 |
| 11 | 10.9 | 1.7 | 71 | 70.1 | 11.1 | 131 | 129.4 | 20.5 | 191 | 188.6 | 29.9 | 251 | 247.9 | 39.3 |
| 12 | 11.9 | 1.9 | 72 | 71.1 | 11.3 | 32 | 130.4 | 20.6 | 92 | 189.6 | 30.0 | 52 | 248.9 | 39.4 |
| 13 | 12.8 | 2.0 | 73 | 72.1 | 11.4 | 33 | 131.4 | 20.8 | 93 | 190.6 | 30.2 | 53 | 249.9 | 39.6 |
| 14 | 13.8 | 2.2 | 74 | 73.1 | 11.6 | 34 | 132.4 | 21.0 | 94 | 191.6 | 30.3 | 54 | 250.9 | 39.7 |
| 15 | 14.8 | 2.3 | 75 | 74.1 | 11.7 | 35 | 133.3 | 21.1 | 95 | 192.6 | 30.5 | 55 | 251.9 | 39.9 |
| 16 | 15.8 | 2.5 | 76 | 75.1 | 11.9 | 36 | 134.3 | 21.3 | 96 | 193.6 | 30.7 | 56 | 252.8 | 40.0 |
| 17 | 16.8 | 2.7 | 77 | 76.1 | 12.0 | 37 | 135.3 | 21.4 | 97 | 194.6 | 30.8 | 57 | 253.8 | 40.2 |
| 18 | 17.8 | 2.8 | 78 | 77.0 | 12.2 | 38 | 136.3 | 21.6 | 98 | 195.6 | 31.0 | 58 | 254.8 | 40.4 |
| 19 | 18.8 | 3.0 | 79 | 78.0 | 12.4 | 39 | 137.3 | 21.7 | 99 | 196.5 | 31.1 | 59 | 255.8 | 40.5 |
| 20 | 19.8 | 3.1 | 80 | 79.0 | 12.5 | 40 | 138.3 | 21.9 | 200 | 197.5 | 31.3 | 60 | 256.8 | 40.7 |
| 21 | 20.7 | 3.3 | 81 | 80.0 | 12.7 | 141 | 139.3 | 22.1 | 201 | 198.5 | 31.4 | 261 | 257.8 | 40.8 |
| 22 | 21.7 | 3.4 | 82 | 81..0 | 12.8 | 42 | 140.3 | 22.2 | 02 | 199.5 | 31.6 | 62 | 258.8 | 41.0 |
| 23 | 22.7 | 3.6 | 83 | 82.0 | 13.0 | 43 | 141.2 | 22.4 | 03 | 200.5 | 31.8 | 63 | 259.8 | 41.1 |
| 24 | 23.7 | 3.8 | 84 | 83.0 | 13.1 | 44 | 142.2 | 22.5 | 04 | 201.5 | 31.9 | 64 | 260.7 | 41.3 |
| 25 | 24.7 | 3.9 | 85 | 84.0 | 13.3 | 45 | 143.2 | 22.7 | 05 | 202.5 | 32.1 | 65 | 261.7 | 41.5 |
| 26 | 25.7 | 4.1 | 86 | 84.9 | 13.5 | 46 | 144.2 | 22.8 | 06 | 203.5 | 32.2 | 66 | 262.7 | 41.6 |
| 27 | 26.7 | 4.2 | 87 | 85.9 | 13.6 | 47 | 145.2 | 23.0 | 07 | 204.5 | 32.4 | 67 | 263.7 | 41.8 |
| 28 | 27.7 | 4.4 | 88 | 86.9 | 13.8 | 48 | 146.2 | 23.2 | 08 | 205.4 | 32.5 | 68 | 264.7 | 41.9 |
| 29 | 28.6 | 4.5 | 89 | 87.9 | 13.9 | 49 | 147.2 | 23.3 | 09 | 206.4 | 32.7 | 69 | 265.7 | 42.1 |
| 30 | 29.6 | 4.7 | 90 | 88.9 | 14.1 | 50 | 148.2 | 23.5 | 10 | 207.4 | 32.9 | 70 | 266.7 | 42.2 |
| 31 | 30.6 | 4.8 | 91 | 89.9 | 14.2 | 151 | 149.1 | 23.6 | 211 | 208.4 | 33.0 | 271 | 267.7 | 42.4 |
| 32 | 31.6 | 5.0 | 92 | 90.9 | 14.4 | 52 | 150.1 | 23.8 | 12 | 209.4 | 33.2 | 72 | 268.7 | 42.6 |
| 33 | 32.6 | 5.2 | 93 | 91.9 | 14.5 | 53 | 151.1 | 23.9 | 13 | 210.4 | 33.3 | 73 | 269.6 | 42.7 |
| 34 | 33.6 | 5.3 | 94 | 92.8 | 14.7 | 54 | 152.1 | 24.1 | 14 | 211.4 | 33.5 | 74 | 270.6 | 42.9 |
| 35 | 34.6 | 5.5 | 95 | 93.8 | 14.9 | 55 | 153.1 | 24.2 | 15 | 212.4 | 33.6 | 75 | 271.6 | 43.0 |
| 36 | 35.6 | 5.6 | 96 | 94.8 | 15.0 | 56 | 154.1 | 24.4 | 16 | 213.3 | 33.8 | 76 | 272.6 | 43.2 |
| 37 | 36.5 | 5.8 | 97 | 95.8 | 15.2 | 57 | 155.1 | 24.6 | 17 | 214.3 | 33.9 | 77 | 273.6 | 43.3 |
| 38 | 37.5 | 5.9 | 98 | 96.8 | 15.3 | 58 | 156.1 | 24.7 | 18 | 215.3 | 34.1 | 78 | 274.6 | 43.5 |
| 39 | 38.5 | 6.1 | 99 | 97.8 | 15.5 | 59 | 157.0 | 24.9 | 19 | 216.3 | 34.3 | 79 | 275.6 | 43.6 |
| 40 | 39.5 | 6.3 | 100 | 98.8 | 15.6 | 60 | 158.0 | 25.0 | 20 | 217.3 | 34.4 | 80 | 276.6 | 43.8 |
| 41 | 40.5 | 6.4 | 101 | 99.8 | 15.8 | 161 | 159.0 | 25.2 | 221 | 218.3 | 34.6 | 281 | 277.5 | 44.0 |
| 42 | 41.5 | 6.6 | 02 | 100.7 | 16.0 | 62 | 160.0 | 25.3 | 22 | 219.3 | 34.7 | 82 | 278.5 | 44.1 |
| 43 | 42.5 | 6.7 | 03 | 101.7 | 16.1 | 63 | 161.0 | 25.5 | 23 | 220.3 | 34.9 | 83 | 279.5 | 44.3 |
| 44 | 43.5 | 6.9 | 04 | 102.7 | 16.3 | 64 | 162.0 | 25.7 | 24 | 221.2 | 35.0 | 84 | 280.5 | 44.4 |
| 45 | 44.4 | 7.0 | 05 | 103.7 | 16.4 | 65 | 163.0 | 25.8 | 25 | 222.2 | 35.2 | 85 | 281.5 | 44.6 |
| 46 | 45.4 | 7.2 | 06 | 104.7 | 16.6 | 66 | 164.0 | 26.0 | 26 | 223.2 | 35.4 | 86 | 282.5 | 44.7 |
| 47 | 46.4 | 7.4 | 07 | 105.7 | 16.7 | 67 | 164.9 | 26.1 | 27 | 224.2 | 35.5 | 87 | 283.5 | 44.9 |
| 48 | 47.4 | 7.5 | 08 | 106.7 | 16.9 | 68 | 165.9 | 26.3 | 28 | 225.2 | 35.7 | 88 | 284.5 | 45.1 |
| 49 | 48.4 | 7.7 | 09 | 107.7 | 17.1 | 69 | 166.9 | 26.4 | 29 | 226.2 | 35.8 | 89 | 285.4 | 45.2 |
| 50 | 49.4 | 7.8 | 10 | 108.6 | 17.2 | 70 | 167.9 | 26.6 | 30 | 227.2 | 36.0 | 90 | 286.4 | 45.4 |
| 51 | 50.4 | 8.0 | 111 | 109.6 | 17.4 | 171 | 168.9 | 26.8 | 231 | 228.2 | 36.1 | 291 | 287.4 | 45.5 |
| 52 | 51.4 | 8.1 | 12 | 110.6 | 17.5 | 72 | 169.9 | 26.9 | 32 | 229.1 | 36.3 | 92 | 288.4 | 45.7 |
| 53 | 52.3 | 8.3 | 13 | 111.6 | 17.7 | 73 | 170.9 | 27.1 | 33 | 230.1 | 36.4 | 93 | 289.4 | 45.8 |
| 54 | 53.3 | 8.4 | 14 | 112.6 | 17.8 | 74 | 171.9 | 27.2 | 34 | 231.1 | 36.6 | 94 | 290.4 | 46.0 |
| 55 | 54.3 | 8.6 | 15 | 113.6 | 18.0 | 75 | 172.8 | 27.4 | 35 | 232.1 | 36.8 | 95 | 291.4 | 46.1 |
| 56 | 55.3 | 8.8 | 16 | 114.6 | 18.1 | 76 | 173.8 | 27.5 | 36 | 233.1 | 36.9 | 96 | 292.4 | 46.3 |
| 57 | 56.3 | 8.9 | 17 | 115.6 | 18.3 | 77 | 174.8 | 27.7 | 37 | 234.1 | 37.1 | 97 | 293.3 | 46.5 |
| 58 | 57.3 | 9.1 | 18 | 116.5 | 18.5 | 78 | 175.8 | 27.8 | 38 | 235.1 | 37.2 | 98 | 294.3 | 46.6 |
| 59 | 58.3 | 9.2 | 19 | 117.5 | 18.6 | 79 | 176.8 | 28.0 | 39 | 236.1 | 37.4 | 99 | 295.3 | 46.8 |
| 60 | 59.3 | 9.4 | ·20 | 118.5 | 18.8 | 80 | 177.8 | 28.2 | 40 | 237.0 | 37.5 | 300 | 296.3 | 46.9 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

81° (99°, 261°, 279°).

TABLE 2. [Page 385

Difference of Latitude and Departure for 9° (171°, 189°, 351°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 297.3 | 47.1 | 361 | 356.6 | 56.5 | 421 | 415.8 | 65.9 | 481 | 475.1 | 75.2 | 541 | 534.4 | 84.6 |
| 02 | 298.3 | 47.2 | 62 | 357.5 | 56.7 | 22 | 416.8 | 66.0 | 82 | 476.1 | 75.3 | 42 | 535.4 | 84.7 |
| 03 | 299.3 | 47.4 | 63 | 358.5 | 56.8 | 23 | 417.8 | 66.2 | 83 | 477.1 | 75.5 | 43 | 536.3 | 84.9 |
| 04 | 300.3 | 47.6 | 64 | 359.5 | 56.9 | 24 | 418.8 | 66.3 | 84 | 478.0 | 75.6 | 44 | 537.3 | 85.1 |
| 05 | 301.2 | 47.7 | 65 | 360.5 | 57.1 | 25 | 419.8 | 66.5 | 85 | 479.0 | 75.8 | 45 | 538.3 | 85.3 |
| 06 | 302.2 | 47.9 | 66 | 361.5 | 57.3 | 26 | 420.8 | 66.6 | 86 | 480.0 | 75.9 | 46 | 539.3 | 85.4 |
| 07 | 303.2 | 48.0 | 67 | 362.5 | 57.4 | 27 | 421.7 | 66.8 | 87 | 481.0 | 76.1 | 47 | 540.3 | 85.6 |
| 08 | 304.2 | 48.2 | 68 | 363.5 | 57.6 | 28 | 422.7 | 67.0 | 88 | 482.0 | 76.2 | 48 | 541.3 | 85.7 |
| 09 | 305.2 | 48.3 | 69 | 364.5 | 57.7 | 29 | 423.7 | 67.1 | 89 | 483.0 | 76.4 | 49 | 542.3 | 85.9 |
| 10 | 306.2 | 48.5 | 70 | 365.4 | 57.9 | 30 | 424.7 | 67.3 | 90 | 484.0 | 76.5 | 50 | 543.3 | 86.0 |
| 311 | 307.2 | 48.7 | 371 | 366.4 | 58.1 | 431 | 425.7 | 67.4 | 491 | 485.0 | 76.7 | 551 | 544.3 | 86.2 |
| 12 | 308.2 | 48.8 | 72 | 367.4 | 58.2 | 32 | 426.7 | 67.6 | 92 | 485.9 | 76.8 | 52 | 545.2 | 86.3 |
| 13 | 309.1 | 49.0 | 73 | 368.4 | 58.4 | 33 | 427.7 | 67.7 | 93 | 486.9 | 77.0 | 53 | 546.2 | 86.5 |
| 14 | 310.1 | 49.1 | 74 | 369.4 | 58.5 | 34 | 428.7 | 67.9 | 94 | 487.9 | 77.1 | 54 | 547.2 | 86.6 |
| 15 | 311.1 | 49.3 | 75 | 370.4 | 58.7 | 35 | 429.6 | 68.1 | 95 | 488.9 | 77.3 | 55 | 548.2 | 86.8 |
| 16 | 312.1 | 49.4 | 76 | 371.4 | 58.8 | 36 | 430.6 | 68.2 | 96 | 489.9 | 77.5 | 56 | 549.2 | 87.0 |
| 17 | 313.1 | 49.6 | 77 | 372.4 | 59.0 | 37 | 431.6 | 68.4 | 97 | 490.9 | 77.7 | 57 | 550.2 | 87.1 |
| 18 | 314.1 | 49.8 | 78 | 373.3 | 59.1 | 38 | 432.6 | 68.5 | 98 | 491.9 | 77.9 | 58 | 551.2 | 87.3 |
| 19 | 315.1 | 49.9 | 79 | 374.3 | 59.3 | 39 | 433.6 | 68.7 | 99 | 492.9 | 78.0 | 59 | 552.2 | 87.4 |
| 20 | 316.1 | 50.1 | 80 | 375.3 | 59.5 | 40 | 434.6 | 68.8 | 500 | 493.8 | 78.2 | 60 | 553.1 | 87.6 |
| 321 | 317.0 | 50.2 | 381 | 376.3 | 59.6 | 441 | 435.6 | 69.0 | 501 | 494.8 | 78.4 | 561 | 554.1 | 87.7 |
| 22 | 318.0 | 50.4 | 82 | 377.3 | 59.8 | 42 | 436.6 | 69.1 | 02 | 495.8 | 78.5 | 62 | 555.1 | 87.9 |
| 23 | 319.0 | 50.5 | 83 | 378.3 | 59.9 | 43 | 437.5 | 69.3 | 03 | 496.8 | 78.7 | 63 | 556.1 | 88.0 |
| 24 | 320.0 | 50.7 | 84 | 379.3 | 60.1 | 44 | 438.5 | 69.4 | 04 | 497.8 | 78.8 | 64 | 557.1 | 88.2 |
| 25 | 321.0 | 50.8 | 85 | 380.3 | 60.2 | 45 | 439.5 | 69.6 | 05 | 498.8 | 79.0 | 65 | 558.1 | 88.3 |
| 26 | 322.0 | 51.0 | 86 | 381.2 | 60.4 | 46 | 440.5 | 69.8 | 06 | 499.8 | 79.1 | 66 | 559.1 | 88.5 |
| 27 | 323.0 | 51.2 | 87 | 382.2 | 60.5 | 47 | 441.5 | 69.9 | 07 | 500.8 | 79.2 | 67 | 560.1 | 88.6 |
| 28 | 324.0 | 51.3 | 88 | 383.2 | 60.7 | 48 | 442.5 | 70.1 | 08 | 501.7 | 79.4 | 68 | 561.0 | 88.8 |
| 29 | 324.9 | 51.5 | 89 | 384.2 | 60.9 | 49 | 443.5 | 70.2 | 09 | 502.7 | 79.5 | 69 | 562.0 | 88.9 |
| 30 | 325.9 | 51.7 | 90 | 385.2 | 61.0 | 50 | 444.5 | 70.4 | 10 | 503.7 | 79.7 | 70 | 563.0 | 89.1 |
| 331 | 326.9 | 51.8 | 391 | 386.2 | 61.2 | 451 | 445.4 | 70.6 | 511 | 504.7 | 79.8 | 571 | 564.0 | 89.2 |
| 32 | 327.9 | 51.9 | 92 | 387.2 | 61.3 | 52 | 446.4 | 70.7 | 12 | 505.7 | 80.1 | 72 | 565.0 | 89.4 |
| 33 | 328.9 | 52.1 | 93 | 388.2 | 61.5 | 53 | 447.4 | 70.9 | 13 | 506.7 | 80.2 | 73 | 566.0 | 89.5 |
| 34 | 329.9 | 52.3 | 94 | 389.1 | 61.6 | 54 | 448.4 | 71.0 | 14 | 507.7 | 80.3 | 74 | 567.0 | 89.7 |
| 35 | 330.9 | 52.4 | 95 | 390.1 | 61.8 | 55 | 449.4 | 71.2 | 15 | 508.7 | 80.5 | 75 | 568.0 | 89.9 |
| 36 | 331.9 | 52.6 | 96 | 391.1 | 62.0 | 56 | 450.4 | 71.3 | 16 | 509.6 | 80.6 | 76 | 568.9 | 90.1 |
| 37 | 332.8 | 52.7 | 97 | 392.1 | 62.1 | 57 | 451.4 | 71.5 | 17 | 510.6 | 80.8 | 77 | 569.9 | 90.2 |
| 38 | 333.8 | 52.9 | 98 | 393.1 | 62.3 | 58 | 452.4 | 71.7 | 18 | 511.6 | 80.9 | 78 | 570.9 | 90.3 |
| 39 | 334.8 | 53.0 | 99 | 394.1 | 62.4 | 59 | 453.3 | 71.8 | 19 | 512.6 | 81.1 | 79 | 571.9 | 90.5 |
| 40 | 335.8 | 53.2 | 400 | 395.1 | 62.6 | 60 | 454.3 | 72.0 | 20 | 513.6 | 81.3 | 80 | 572.9 | 90.7 |
| 341 | 336.8 | 53.3 | 401 | 396.1 | 62.7 | 461 | 455.3 | 72.1 | 521 | 514.6 | 81.4 | 581 | 573.9 | 90.9 |
| 42 | 337.8 | 53.5 | 02 | 397.0 | 62.9 | 62 | 456.3 | 72.3 | 22 | 515.6 | 81.6 | 82 | 574.9 | 91.0 |
| 43 | 338.8 | 53.7 | 03 | 398.0 | 63.0 | 63 | 457.3 | 72.4 | 23 | 516.6 | 81.8 | 83 | 575.9 | 91.2 |
| 44 | 339.8 | 53.8 | 04 | 399.0 | 63.2 | 64 | 458.3 | 72.6 | 24 | 517.6 | 81.9 | 84 | 576.9 | 91.3 |
| 45 | 340.8 | 54.0 | 05 | 400.0 | 63.4 | 65 | 459.3 | 72.7 | 25 | 518.6 | 82.1 | 85 | 577.9 | 91.5 |
| 46 | 341.7 | 54.1 | 06 | 401.0 | 63.5 | 66 | 460.3 | 72.9 | 26 | 519.5 | 82.3 | 86 | 578.8 | 91.7 |
| 47 | 342.7 | 54.3 | 07 | 402.0 | 63.7 | 67 | 461.2 | 73.1 | 27 | 520.5 | 82.4 | 87 | 579.8 | 91.8 |
| 48 | 343.7 | 54.4 | 08 | 403.0 | 63.8 | 68 | 462.2 | 73.2 | 28 | 521.5 | 82.6 | 88 | 580.8 | 92.0 |
| 49 | 344.7 | 54.6 | 09 | 404.0 | 64.0 | 69 | 463.2 | 73.4 | 29 | 522.5 | 82.7 | 89 | 581.8 | 92.1 |
| 50 | 345.7 | 54.8 | 10 | 405.0 | 64.1 | 70 | 464.2 | 73.5 | 30 | 523.5 | 82.9 | 90 | 582.8 | 92.2 |
| 351 | 346.7 | 54.9 | 411 | 405.9 | 64.3 | 471 | 465.2 | 73.7 | 531 | 524.5 | 83.1 | 591 | 583.8 | 92.4 |
| 52 | 347.7 | 55.1 | 12 | 406.9 | 64.5 | 72 | 466.2 | 73.8 | 32 | 525.5 | 83.2 | 92 | 584.8 | 92.5 |
| 53 | 348.7 | 55.2 | 13 | 407.9 | 64.6 | 73 | 467.2 | 74.0 | 33 | 526.5 | 83.4 | 93 | 585.7 | 92.7 |
| 54 | 349.6 | 55.4 | 14 | 408.9 | 64.8 | 74 | 468.2 | 74.2 | 34 | 527.5 | 83.5 | 94 | 586.7 | 92.9 |
| 55 | 350.6 | 55.5 | 15 | 409.9 | 64.9 | 75 | 469.2 | 74.3 | 35 | 528.4 | 83.7 | 95 | 587.7 | 93.1 |
| 56 | 351.6 | 55.7 | 16 | 410.9 | 65.1 | 76 | 470.1 | 74.5 | 36 | 529.4 | 83.8 | 96 | 588.7 | 93.2 |
| 57 | 352.6 | 55.9 | 17 | 411.9 | 65.2 | 77 | 471.1 | 74.6 | 37 | 530.4 | 84.0 | 97 | 589.7 | 93.4 |
| 58 | 353.6 | 56.0 | 18 | 412.9 | 65.4 | 78 | 472.1 | 74.8 | 38 | 531.4 | 84.1 | 98 | 590.7 | 93.5 |
| 59 | 354.6 | 56.2 | 19 | 413.8 | 65.6 | 79 | 473.1 | 74.9 | 39 | 532.4 | 84.3 | 99 | 591.7 | 93.7 |
| 60 | 355.6 | 56.3 | 20 | 414.8 | 65.7 | 80 | 474.1 | 75.0 | 40 | 533.4 | 84.4 | 600 | 592.6 | 93.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

81° (99°, 261°, 279°).

# TABLE 2.

Difference of Latitude and Departure for 10° (170°, 190°, 350°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 60.1 | 10.6 | 121 | 119.2 | 21.0 | 181 | 178.3 | 31.4 | 241 | 237.3 | 41.8 |
| 2 | 2.0 | 0.3 | 62 | 61.1 | 10.8 | 22 | 120.1 | 21.2 | 82 | 179.2 | 31.6 | 42 | 238.3 | 42.0 |
| 3 | 3.0 | 0.5 | ·63 | 62.0 | 10.9 | 23 | 121.1 | 21.4 | 83 | 180.2 | 31.8 | 43 | 239.3 | 42.2 |
| 4 | 3.9 | 0.7 | 64 | 63.0 | 11.1 | 24 | 122.1 | 21.5 | 84 | 181.2 | 32.0 | 44 | 240.3 | 42.4 |
| 5 | 4.9 | 0.9 | 65 | 64.0 | 11.3 | 25 | 123.1 | 21.7 | 85 | 182.2 | 32.1 | 45 | 241.3 | 42.5 |
| 6 | 5.9 | 1.0 | 66 | 65.0 | 11.5 | 26 | 124.1 | 21.9 | 86 | 183.2 | 32.3 | 46 | 242.3 | 42.7 |
| 7 | 6.9 | 1.2 | 67 | 66.0 | 11.6 | 27 | 125.1 | 22.1 | 87 | 184.2 | 32.5 | 47 | 243.2 | 42.9 |
| 8 | 7.9 | 1.4 | 68 | 67.0 | 11.8 | 28 | 126.1 | 22.2 | 88 | 185.1 | 32.6 | 48 | 244.2 | 43.1 |
| 9 | 8.9 | 1.6 | 69 | 68.0 | 12.0 | 29 | 127.0 | 22.4 | 89 | 186.1 | 32.8 | 49 | 245.2 | 43.2 |
| 10 | 9.8 | 1.7 | 70 | 68.9 | 12.2 | 30 | 128.0 | 22.6 | 90 | 187.1 | 33.0 | 50 | 246.2 | 43.4 |
| 11 | 10.8 | 1.9 | 71 | 69.9 | 12.3 | 131 | 129.0 | 22.7 | 191 | 188.1 | 33.2 | 251 | 247.2 | 43.6 |
| 12 | 11 8 | 2.1 | 72 | 70.9 | 12.5 | 32 | 130.0 | 22.9 | 92 | 189.1 | 33.3 | 52 | 248.2 | 43.8 |
| 13 | 12.8 | 2.3 | 73 | 71.9 | 12.7 | 33 | 131.0 | 23.1 | 93 | 190.1 | 33.5 | 53 | 249.2 | 43.9 |
| 14 | 13.8 | 2.4 | 74 | 72.9 | 12.8 | 34 | 132.0 | 23.3 | 94 | 191.1 | 33.7 | 54 | 250.1 | 44.1 |
| 15 | 14.8 | 2.6 | 75 | 73.9 | 13.0 | 35 | 132.9 | 23.4 | 95 | 192.0 | 33.9 | 55 | 251.1 | 44.3 |
| 16 | 15.8 | 2.8 | 76 | 74.8 | 13.2 | 36 | 133.9 | 23.6 | 96 | 193.0 | 34.0 | 56 | 252.1 | 44.5 |
| 17 | 16.7 | 3.0 | 77 | 75.8 | 13.4 | 37 | 134.9 | 23.8 | 97 | 194.0 | 34.2 | 57 | 253.1 | 44.6 |
| 18 | 17.7 | 3.1 | 78 | 76.8 | 13.5 | 38 | 135.9 | 24.0 | 98 | 195.0 | 34.4 | 58 | 254.1 | 44.8 |
| 19 | 18.7 | 3.3 | 79 | 77.8 | 13.7 | 39 | 136.9 | 24.1 | 99 | 196.0 | 34.6 | 59 | 255.1 | 45.0 |
| 20 | 19.7 | 3.5 | 80 | 78.8 | 13.9 | 40 | 137.9 | 24.3 | 200 | 197.0 | 34.7 | 60 | 256.1 | 45.1 |
| 21 | 20.7 | 3.6 | 81 | 79.8 | 14.1 | 141 | 138.9 | 24.5 | 201 | 197.9 | 34.9 | 261 | 257.0 | 45.3 |
| 22 | 21.7 | 3.8 | 82 | 80.8 | 14.2 | 42 | 139.8 | 24.7 | 02 | 198.9 | 35.1 | 62 | 258.0 | 45.5 |
| 23 | 22.7 | 4.0 | 83 | 81.7 | 14.4 | 43 | 140.8 | 24.8 | 03 | 199.9 | 35.3 | 63 | 259.0 | 45.7 |
| 24 | 23.6 | 4.2 | 84 | 82.7 | 14.6 | 44 | 141.8 | 25.0 | 04 | 200.9 | 35.4 | 64 | 260.0 | 45.8 |
| 25 | 24.6 | 4.3 | 85 | 83.7 | 14.8 | 45 | 142.8 | 25.2 | 05 | 201.9 | 35.6 | 65 | 261.0 | 46.0 |
| 26 | 25.6 | 4.5 | 86 | 84.7 | 14.9 | 46 | 143.8 | 25.4 | 06 | 202.9 | 35.8 | 66 | 262.0 | 46.2 |
| 27 | 26.6 | 4.7 | 87 | 85.7 | 15.1 | 47 | 144.8 | 25.5 | 07 | 203.9 | 35.9 | 67 | 262.9 | 46.4 |
| 28 | 27.6 | 4.9 | 88 | 86.7 | 15.3 | 48 | 145.8 | 25.7 | 08 | 204.8 | 36.1 | 68 | 263.9 | 46.5 |
| 29 | 28.6 | 5.0 | 89 | 87.6 | 15.5 | 49 | 146.7 | 25.9 | 09 | 205.8 | 36.3 | 69 | 264.9 | 46.7 |
| 30 | 29.5 | 5.2 | 90 | 88.6 | 15.6 | 50 | 147.7 | 26.0 | 10 | 206.8 | 36.5 | 70 | 265.9 | 46.9 |
| 31 | 30.5 | 5.4 | 91 | 89.6 | 15.8 | 151 | 148.7 | 26.2 | 211 | 207.8 | 36.6 | 271 | 266.9 | 47.1 |
| 32 | 31.5 | 5.6 | 92 | 90.6 | 16.0 | 52 | 149.7 | 26.4 | 12 | 208.8 | 36.8 | 72 | 267.9 | 47.2 |
| 33 | 32.5 | 5.7 | 93 | 91.6 | 16.1 | 53 | 150.7 | 26.6 | 13 | 209.8 | 37.0 | 73 | 268.9 | 47.4 |
| 34 | 33.5 | 5.9 | 94 | 92.6 | 16.3 | 54 | 151.7 | 26.7 | 14 | 210.7 | 37.2 | 74 | 269.8 | 47.6 |
| 35 | 34.5 | 6.1 | 95 | 93.6 | 16.5 | 55 | 152.6 | 26.9 | 15 | 211.7 | 37.3 | 75 | 270.8 | 47.8 |
| 36 | 35.5 | 6.3 | 96 | 94.5 | 16.7 | 56 | 153.6 | 27.1 | 16 | 212.7 | 37.5 | 76 | 271.8 | 47.9 |
| 37 | 36.4 | 6.4 | 97 | 95.5 | 16.8 | 57 | 154.6 | 27.3 | 17 | 213.7 | 37.7 | 77 | 272.8 | 48.1 |
| 38 | 37.4 | 6.6 | 98 | 96.5 | 17.0 | 58 | 155.6 | 27.4 | 18 | 214.7 | 37.9 | 78 | 273.8 | 48.3 |
| 39 | 38.4 | 6.8 | 99 | 97.5 | 17.2 | 59 | 156.6 | 27.6 | 19 | 215.7 | 38.0 | 79 | 274.8 | 48.4 |
| 40 | 39.4 | 6.9 | 100 | 98.5 | 17.4 | 60 | 157.6 | 27.8 | 20 | 216.7 | 38.2 | 80 | 275.7 | 48.6 |
| 41 | 40.4 | 7.1 | 101 | 99.5 | 17.5 | 161 | 158.6 | 28.0 | 221 | 217.6 | 38.4 | 281 | 276.7 | 48.8 |
| 42 | 41.4 | 7.3 | 02 | 100.5 | 17.7 | 62 | 159.5 | 28.1 | 22 | 218.6 | 38.5 | 82 | 277.7 | 49.0 |
| 43 | 42.3 | 7.5 | 03 | 101.4 | 17.9 | 63 | 160.5 | 28.3 | 23 | 219.6 | 38.7 | 83 | 278.7 | 49.1 |
| 44 | 43.3 | 7.6 | 04 | 102.4 | 18.1 | 64 | 161.5 | 28.5 | 24 | 220.6 | 38.9 | 84 | 279.7 | 49.3 |
| 45 | 44.3 | 7.8 | 05 | 103.4 | 18.2 | 65 | 162.5 | 28.7 | 25 | 221.6 | 39.1 | 85 | 280.7 | 49.5 |
| 46 | 45.3 | 8.0 | 06 | 104.4 | 18.4 | 66 | 163.5 | 28.8 | 26 | 222.6 | 39.2 | 86 | 281.7 | 49.7 |
| 47 | 46.3 | 8.2 | 07 | 105.4 | 18.6 | 67 | 164.5 | 29.0 | 27 | 223.6 | 39.4 | 87 | 282.6 | 49.8 |
| 48 | 47.3 | 8.3 | 08 | 106.4 | 18.8 | 68 | 165.4 | 29.2 | 28 | 224.5 | 39.6 | 88 | 283.6 | 50.0 |
| 49 | 48.3 | 8.5 | 09 | 107.3 | 18.9 | 69 | 166.4 | 29.3 | 29 | 225.5 | 39.8 | 89 | 284.6 | 50.2 |
| 50 | 49.2 | 8.7 | 10 | 108.3 | 19.1 | 70 | 167.4 | 29.5 | 30 | 226.5 | 39.9 | 90 | 285.6 | 50.4 |
| 51 | 50.2 | 8.9 | 111 | 109.3 | 19.3 | 171 | 168.4 | 29.7 | 231 | 227.5 | 40.1 | 291 | 286.6 | 50.5 |
| 52 | 51.2 | 9.0 | 12 | 110.3 | 19.4 | 72 | 169.4 | 29.9 | 32 | 228.5 | 40.3 | 92 | 287.6 | 50.7 |
| 53 | 52.2 | 9.2 | 13 | 111.3 | 19.6 | 73 | 170.4 | 30.0 | 33 | 229.5 | 40.5 | 93 | 288.5 | 50.9 |
| 54 | 53.2 | 9.4 | 14 | 112.3 | 19.8 | 74 | 171.4 | 30.2 | 34 | 230.4 | 40.6 | 94 | 289.5 | 51.1 |
| 55 | 54.2 | 9.6 | 15 | 113.3 | 20.0 | 75 | 172.3 | 30.4 | 35 | 231.4 | 40.8 | 95 | 290.5 | 51.2 |
| 56 | 55.1 | 9.7 | 16 | 114.2 | 20.1 | 76 | 173.3 | 30.6 | 36 | 232.4 | 41.0 | 96 | 291.5 | 51.4 |
| 57 | 56.1 | 9.9 | 17 | 115.2 | 20.3 | 77 | 174.3 | 30.7 | 37 | 233.4 | 41.2 | 97 | 292.5 | 51.6 |
| 58 | 57.1 | 10.1 | 18 | 116.2 | 20.5 | 78 | 175.3 | 30.9 | 38 | 234.4 | 41.3 | 98 | 293.5 | 51.7 |
| 59 | 58.1 | 10.2 | 19 | 117.2 | 20.7 | 79 | 176.3 | 31.1 | 39 | 235.4 | 41.5 | 99 | 294.5 | 51.9 |
| 60 | 59.1 | 10.4 | 20 | 118.2 | 20.8 | 80 | 177.3 | 31.3 | 40 | 236.4 | 41.7 | 300 | 295.4 | 52.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

80° (100°, 260°, 280°).

TABLE 2. [Page 387

Difference of Latitude and Departure for 10° (170°, 190°, 350°)

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 296. 4 | 52. 3 | 361 | 355. 5 | 62. 7 | 421 | 414. 6 | 73. 1 | 481 | 473. 7 | 83. 5 | 541 | 532. 8 | 93. 9 |
| 02 | 297. 4 | 52. 5 | 62 | 356. 5 | 62. 9 | 22 | 415. 6 | 73. 3 | 82 | 474. 7 | 83. 7 | 42 | 533. 8 | 94. 1 |
| 03 | 298. 4 | 52. 6 | 63 | 357. 5 | 63. 0 | 23 | 416. 6 | 73. 5 | 83 | 475. 7 | 83. 9 | 43 | 534. 8 | 94. 3 |
| 04 | 299. 4 | 52. 8 | 64 | 358. 5 | 63. 2 | 24 | 417. 6 | 73. 6 | 84 | 476. 6 | 84. 1 | 44 | 535. 7 | 94. 5 |
| 05 | 300. 4 | 53. 0 | 65 | 359. 5 | 63. 4 | 25 | 418. 5 | 73. 8 | 85 | 477. 6 | 84. 2 | 45 | 536. 7 | 94. 6 |
| 06 | 301. 4 | 53. 1 | 66 | 360. 4 | 63. 6 | 26 | 419. 5 | 74. 0 | 86 | 478. 6 | 84. 4 | 46 | 537. 7 | 94. 8 |
| 07 | 302. 3 | 53. 3 | 67 | 361. 4 | 63. 7 | 27 | 420. 5 | 74. 2 | 87 | 479. 6 | 84. 6 | 47 | 538. 7 | 95. 0 |
| 08 | 303. 3 | 53. 5 | 68 | 362. 4 | 63. 9 | 28 | 421. 5 | 74. 3 | 88 | 480. 6 | 84. 7 | 48 | 539. 7 | 95. 1 |
| 09 | 304. 3 | 53. 7 | 69 | 363. 4 | 64. 1 | 29 | 422. 5 | 74. 5 | 89 | 481. 6 | 84. 9 | 49 | 540. 7 | 95. 3 |
| 10 | 305. 3 | 53. 8 | 70 | 364. 4 | 64. 3 | 30 | 423. 5 | 74. 7 | 90 | 482. 6 | 85. 1 | 50 | 541. 6 | 95. 5 |
| 311 | 306. 3 | 54. 0 | 371 | 365. 4 | 64. 4 | 431 | 424. 5 | 74. 9 | 491 | 483. 5 | 85. 2 | 551 | 542. 6 | 95. 6 |
| 12 | 307. 3 | 54. 2 | 72 | 366. 4 | 64. 6 | 32 | 425. 4 | 75. 0 | 92 | 484. 5 | 85. 4 | 52 | 543. 6 | 95. 8 |
| 13 | 308. 2 | 54. 3 | 73 | 367. 3 | 64. 8 | 33 | 426. 4 | 75. 2 | 93 | 485. 5 | 85. 6 | 53 | 544. 6 | 96. 0 |
| 14 | 309. 2 | 54. 5 | 74 | 368. 3 | 65. 0 | 34 | 427. 4 | 75. 4 | 94 | 486. 5 | 85. 8 | 54 | 545. 6 | 96. 2 |
| 15 | 310. 2 | 54. 7 | 75 | 369. 3 | 65. 1 | 35 | 428. 4 | 75. 5 | 95 | 487. 5 | 85. 9 | 55 | 546. 6 | 96. 3 |
| 16 | 311. 2 | 54. 9 | 76 | 370. 3 | 65. 3 | 36 | 429. 4 | 75. 7 | 96 | 488. 5 | 86. 1 | 56 | 547. 5 | 96. 5 |
| 17 | 312. 2 | 55. 1 | 77 | 371. 3 | 65. 5 | 37 | 430. 4 | 75. 9 | 97 | 489. 4 | 86. 3 | 57 | 548. 5 | 96. 7 |
| 18 | 313. 2 | 55. 2 | 78 | 372. 3 | 65. 6 | 38 | 431. 3 | 76. 1 | 98 | 490. 4 | 86. 5 | 58 | 549. 5 | 96. 9 |
| 19 | 314. 2 | 55. 4 | 79 | 373. 2 | 65. 8 | 39 | 432. 3 | 76. 2 | 99 | 491. 4 | 86. 6 | 59 | 550. 5 | 97. 0 |
| 20 | 315. 1 | 55. 6 | 80 | 374. 2 | 66. 0 | 40 | 433. 3 | 76. 4 | 500 | 492. 4 | 86. 8 | 60 | 551. 5 | 97. 2 |
| 321 | 316. 1 | 55. 8 | 381 | 375. 2 | 66. 2 | 441 | 434. 3 | 76. 6 | 501 | 493. 4 | 87. 0 | 561 | 552. 5 | 97. 4 |
| 22 | 317. 1 | 55. 9 | 82 | 376. 2 | 66. 3 | 42 | 435. 3 | 76. 8 | 02 | 494. 4 | 87. 2 | 62 | 553. 5 | 97. 6 |
| 23 | 318. 1 | 56. 1 | 83 | 377. 2 | 66. 5 | 43 | 436. 3 | 76. 9 | 03 | 495. 3 | 87. 3 | 63 | 554. 4 | 97. 7 |
| 24 | 319. 1 | 56. 3 | 84 | 378. 2 | 66. 7 | 44 | 437. 3 | 77. 1 | 04 | 496. 3 | 87. 5 | 64 | 555. 4 | 97. 9 |
| 25 | 320. 1 | 56. 4 | 85 | 379. 2 | 66. 9 | 45 | 438. 2 | 77. 3 | 05 | 497. 3 | 87. 7 | 65 | 556. 4 | 98. 1 |
| 26 | 321. 0 | 56. 6 | 86 | 380. 1 | 67. 0 | 46 | 439. 2 | 77. 5 | 06 | 498. 3 | 87. 9 | 66 | 557. 4 | 98. 3 |
| 27 | 322. 0 | 56. 8 | 87 | 381. 1 | 67. 2 | 47 | 440. 2 | 77. 6 | 07 | 499. 3 | 88. 0 | 67 | 558. 4 | 98. 4 |
| 28 | 323. 0 | 57. 0 | 88 | 382. 1 | 67. 4 | 48 | 441. 2 | 77. 8 | 08 | 500. 3 | 88. 2 | 68 | 559. 4 | 98. 6 |
| 29 | 324. 0 | 57. 1 | 89 | 383. 1 | 67. 6 | 49 | 442. 2 | 78. 0 | 09 | 501. 3 | 88. 4 | 69 | 560. 3 | 98. 8 |
| 30 | 325. 0 | 57. 3 | 90 | 384. 1 | 67. 7 | 50 | 443. 2 | 78. 2 | 10 | 502. 2 | 88. 6 | 70 | 561. 3 | 99. 0 |
| 331 | 326. 0 | 57. 5 | 391 | 385. 1 | 67. 9 | 451 | 444. 2 | 78. 3 | 511 | 503. 2 | 88. 7 | 571 | 562. 3 | 99. 1 |
| 32 | 327. 0 | 57. 7 | 92 | 386. 0 | 68. 1 | 52 | 445. 1 | 78. 5 | 12 | 504. 2 | 88. 9 | 72 | 563. 3 | 99. 3 |
| 33 | 327. 9 | 57. 8 | 93 | 387. 0 | 68. 2 | 53 | 446. 1 | 78. 7 | 13 | 505. 2 | 89. 1 | 73 | 564. 3 | 99. 5 |
| 34 | 328. 9 | 58. 0 | 94 | 388. 0 | 68. 4 | 54 | 447. 1 | 78. 8 | 14 | 506. 2 | 89. 2 | 74 | 565. 3 | 99. 6 |
| 35 | 329. 9 | 58. 2 | 95 | 389. 0 | 68. 6 | 55 | 448. 1 | 79. 0 | 15 | 507. 2 | 89. 4 | 75 | 566. 3 | 99. 8 |
| 36 | 330. 9 | 58. 4 | 96 | 390. 0 | 68. 8 | 56 | 449. 1 | 79. 2 | 16 | 508. 2 | 89. 6 | 76 | 567. 2 | 100. 0 |
| 37 | 331. 9 | 58. 5 | 97 | 391. 0 | 68. 9 | 57 | 450. 1 | 79. 4 | 17 | 509. 1 | 89. 8 | 77 | 568. 2 | 100. 2 |
| 38 | 332. 9 | 58. 7 | 98 | 392. 0 | 69. 1 | 58 | 451. 0 | 79. 5 | 18 | 510. 1 | 89. 9 | 78 | 569. 2 | 100. 3 |
| 39 | 333. 9 | 58. 9 | 99 | 392. 9 | 69. 3 | 59 | 452. 0 | 79. 7 | 19 | 511. 1 | 90. 1 | 79 | 570. 2 | 100. 5 |
| 40 | 334. 8 | 59. 1 | 400 | 393. 9 | 69. 5 | 60 | 453. 0 | 79. 9 | 20 | 512. 1 | 90. 3 | 80 | 571. 2 | 100. 7 |
| 341 | 335. 8 | 59. 2 | 401 | 394. 9 | 69. 6 | 461 | 454. 0 | 80. 1 | 521 | 513. 1 | 90. 5 | 581 | 572. 2 | 100. 9 |
| 42 | 336. 8 | 59. 4 | 02 | 395. 9 | 69. 8 | 62 | 455. 0 | 80. 2 | 22 | 514. 1 | 90. 6 | 82 | 573. 2 | 101. 0 |
| 43 | 337. 8 | 59. 6 | 03 | 396. 9 | 70. 0 | 63 | 456. 0 | 80. 4 | 23 | 515. 1 | 90. 8 | 83 | 574. 1 | 101. 2 |
| 44 | 338. 8 | 59. 8 | 04 | 397. 9 | 70. 2 | 64 | 457. 0 | 80. 6 | 24 | 516. 0 | 91. 0 | 84 | 575. 1 | 101. 4 |
| 45 | 339. 8 | 59. 9 | 05 | 398. 9 | 70. 3 | 65 | 457. 9 | 80. 8 | 25 | 517. 0 | 91. 2 | 85 | 576. 1 | 101. 6 |
| 46 | 340. 7 | 60. 1 | 06 | 399. 8 | 70. 5 | 66 | 458. 9 | 80. 9 | 26 | 518. 0 | 91. 3 | 86 | 577. 1 | 101. 7 |
| 47 | 341. 7 | 60. 3 | 07 | 400. 8 | 70. 7 | 67 | 459. 9 | 81. 1 | 27 | 519. 0 | 91. 5 | 87 | 578. 1 | 101. 9 |
| 48 | 342. 7 | 60. 4 | 08 | 401. 8 | 70. 9 | 68 | 460. 9 | 81. 3 | 28 | 520. 0 | 91. 7 | 88 | 579. 1 | 102. 1 |
| 49 | 343. 7 | 60. 6 | 09 | 402. 8 | 71. 0 | 69 | 461. 9 | 81. 5 | 29 | 521. 0 | 91. 9 | 89 | 580. 0 | 102. 3 |
| 50 | 344. 7 | 60. 8 | 10 | 403. 8 | 71. 2 | 70 | 462. 9 | 81. 6 | 30 | 521. 9 | 92. 0 | 90 | 581. 0 | 102. 4 |
| 351 | 345. 7 | 61. 0 | 411 | 404. 8 | 71. 4 | 471 | 463. 8 | 81. 8 | 531 | 522. 9 | 92. 2 | 591 | 582. 0 | 102. 6 |
| 52 | 346. 7 | 61. 1 | 12 | 405. 7 | 71. 6 | 72 | 464. 8 | 82. 0 | 32 | 523. 9 | 92. 4 | 92 | 583. 0 | 102. 8 |
| 53 | 347. 6 | 61. 3 | 13 | 406. 7 | 71. 7 | 73 | 465. 8 | 82. 1 | 33 | 524. 9 | 92. 5 | 93 | 584. 0 | 102. 9 |
| 54 | 348. 6 | 61. 5 | 14 | 407. 7 | 71. 9 | 74 | 466. 8 | 82. 3 | 34 | 525. 9 | 92. 7 | 94 | 585. 0 | 103. 1 |
| 55 | 349. 6 | 61. 7 | 15 | 408. 7 | 72. 1 | 75 | 467. 8 | 82. 5 | 35 | 526. 9 | 92. 9 | 95 | 586. 0 | 103. 3 |
| 56 | 350. 6 | 61. 8 | 16 | 409. 7 | 72. 2 | 76 | 468. 8 | 82. 7 | 36 | 527. 9 | 93. 1 | 96 | 586. 9 | 103. 5 |
| 57 | 351. 6 | 62. 0 | 17 | 410. 7 | 72. 4 | 77 | 469. 8 | 82. 8 | 37 | 528. 8 | 93. 2 | 97 | 587. 9 | 103. 6 |
| 58 | 352. 6 | 62. 2 | 18 | 411. 7 | 72. 6 | 78 | 470. 7 | 83. 0 | 38 | 529. 8 | 93. 4 | 98 | 588. 9 | 103. 8 |
| 59 | 353. 5 | 62 4 | 19 | 412. 6 | 72. 8 | 79 | 471. 7 | 83. 2 | 39 | 530. 8 | 93. 6 | 99 | 589. 9 | 104. 0 |
| 60 | 354. 5 | 62. 5 | 20 | 413. 6 | 72. 9 | 80 | 472. 7 | 83. 4 | 40 | 531. 8 | 93. 8 | 600 | 590. 9 | 104. 2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

80° (100°, 260°, 280°).

# TABLE 2.

Difference of Latitude and Departure for 11° (169°, 191°, 349°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1:0 | 0.2 | 61 | 59.9 | 11.6 | 121 | 118.8 | 23.1 | 181 | 177.7 | 34.5 | 241 | 236.6 | 46.0 |
| 2 | 2.0 | 0.4 | 62 | 60.9 | 11.8 | 22 | 119.8 | 23.3 | 82 | 178.7 | 34.7 | 42 | 237.6 | 46.2 |
| 3 | 2 9 | 0.6 | 63 | 61.8 | 12.0 | 23 | 120.7 | 23.5 | 83 | 179.6 | 34.9 | 43 | 238.5 | 46.4 |
| 4 | 3.9 | 0.8 | 64 | 62.8 | 12.2 | 24 | 121.7 | 23.7 | 84 | 180.6 | 35.1 | 44 | 239.5 | 46.6 |
| 5 | 4.9 | 1.0 | 65 | 63.8 | 12.4 | 25 | 122.7 | 23.9 | 85 | 181.6 | 35.3 | 45 | 240.5 | 46.7 |
| 6 | 5.9 | 1.1 | 66 | 64.8 | 12.6 | 26 | 123.7 | 24.0 | 86 | 182.6 | 35.5 | 46 | 241.5 | 46.9 |
| 7 | 6.9 | 1.3 | 67 | 65.8 | 12.8 | 27 | 124.7 | 24.2 | 87 | 183.6 | 35.7 | 47 | 242.5 | 47.1 |
| 8 | 7.9 | 1.5 | 68 | 66.8 | 13.0 | 28 | 125.6 | 24.4 | 88 | 184.5 | 35.9 | 48 | 243.4 | 47.3 |
| 9 | 8.8 | 1.7 | 69 | 67.7 | 13.2 | 29 | 126.6 | 24.6 | 89 | 185.5 | 36.1 | 49 | 244.4 | 47.5 |
| 10 | 9.8 | 1.9 | 70 | 68.7 | 13.4 | 30 | 127.6 | 24.8 | 90 | 186.5 | 36.3 | 50 | 245.4 | 47.7 |
| 11 | 10.8 | 2.1 | 71 | 69.7 | 13.5 | 131 | 128.6 | 25.0 | 191 | 187.5 | 36.4 | 251 | 246.4 | 47.9 |
| 12 | 11.8 | 2.3 | 72 | 70.7 | 13.7 | 32 | 129.6 | 25.2 | 92 | 188.5 | 36.6 | 52 | 247.4 | 48.1 |
| 13 | 12.8 | 2.5 | 73 | 71.7 | 13.9 | 33 | 130.6 | 25.4 | 93 | 189.5 | 36.8 | 53 | 248.4 | 48.3 |
| 14 | 13.7 | 2.7 | 74 | 72.6 | 14.1 | 34 | 131.5 | 25.6 | 94 | 190.4 | 37.0 | 54 | 249.3 | 48.5 |
| 15 | 14.7 | 2.9 | 75 | 73.6 | 14.3 | 35 | 132.5 | 25.8 | 95 | 191.4 | 37.2 | 55 | 250.3 | 48.7 |
| 16 | 15.7 | 3.1 | 76 | 74.6 | 14.5 | 36 | 133.5 | 26.0 | 96 | 192.4 | 37.4 | 56 | 251.3 | 48.8 |
| 17 | 16.7 | 3.2 | 77 | 75.6 | 14.7 | 37 | 134.5 | 26.1 | 97 | 193.4 | 37.6 | 57 | 252.3 | 49.0 |
| 18 | 17.7 | 3.4 | 78 | 76.6 | 14.9 | 38 | 135.5 | 26.3 | 98 | 194.4 | 37.8 | 58 | 253.3 | 49.2 |
| 19 | 18.7 | 3.6 | 79 | 77.5 | 15.1 | 39 | 136.4 | 26.5 | 99 | 195.3 | 38.0 | 59 | 254.2 | 49.4 |
| 20 | 19.6 | 3.8 | 80 | 78.5 | 15.3 | 40 | 137.4 | 26.7 | 200 | 196.3 | 38.2 | 60 | 255.2 | 49.6 |
| 21 | 20.6 | 4.0 | 81 | 79.5 | 15.5 | 141 | 138.4 | 26.9 | 201 | 197.3 | 38.4 | 261 | 256.2 | 49.8 |
| 22 | 21.6 | 4.2 | 82 | 80.5 | 15.6 | 42 | 139.4 | 27.1 | 02 | 198.3 | 38.5 | 62 | 257.2 | 50.0 |
| 23 | 22.6 | 4.4 | 83 | 81.5 | 15.8 | 43 | 140.4 | 27.3 | 03 | 199.3 | 38.7 | 63 | 258.2 | 50.2 |
| 24 | 23.6 | 4.6 | 84 | 82.5 | 16.0 | 44 | 141 4 | 27.5 | 04 | 200.3 | 38.9 | 64 | 259.1 | 50.4 |
| 25 | 24.5 | 4.8 | 85 | 83.4 | 16.2 | 45 | 142.3 | 27.7 | 05 | 201.2 | 39.1 | 65 | 260.1 | 50.6 |
| 26 | 25.5 | 5.0 | 86 | 84.4 | 16.4 | 46 | 143.3 | 27.9 | 06 | 202.2 | 39.3 | 66 | 261.1 | 50.8 |
| 27 | 26.5 | 5.2 | 87 | 85.4 | 16.6 | 47 | 144.3 | 28.0 | 07 | 203.2 | 39.5 | 67 | 262.1 | 50.9 |
| 28 | 27.5 | 5.3 | 88 | 86.4 | 16.8 | 48 | 145.3 | 28.2 | 08 | 204.2 | 39.7 | 68 | 263.1 | 51.1 |
| 29 | 28.5 | 5.5 | 89 | 87.4 | 17.0 | 49 | 146.3 | 28.4 | 09 | 205.2 | 39.9 | 69 | 264.1 | 51.3 |
| 30 | 29.4 | 5.7 | 90 | 88.3 | 17.2 | 50 | 147.2 | 28.6 | 10 | 206.1 | 40.1 | 70 | 265.0 | 51.5 |
| 31 | 30.4 | 5.9 | 91 | 89.3 | 17.4 | 151 | 148.2 | 28.8 | 211 | 207.1 | 40.3 | 271 | 266.0 | 51.7 |
| 32 | 31.4 | 6.1 | 92 | 90.3 | 17.6 | 52 | 149.2 | 29.0 | 12 | 208.1 | 40.5 | 72 | 267.0 | 51.9 |
| 33 | 32.4 | 6.3 | 93 | 91.3 | 17.7 | 53 | 150.2 | 29.2 | 13 | 209.1 | 40.6 | 73 | 268.0 | 52.1 |
| 34 | 33.4 | 6.5 | 94 | 92.3 | 17.9 | 54 | 151.2 | 29.4 | 14 | 210.1 | 40.8 | 74 | 269.0 | 52.3 |
| 35 | 34.4 | 6.7 | 95 | 93.3 | 18.1 | 55 | 152.2 | 29.6 | 15 | 211.0 | 41.0 | 75 | 269.9 | 52.5 |
| 36 | 35.3 | 6.9 | 96 | 94.2 | 18.3 | 56 | 153.1 | 29.8 | 16 | 212.0 | 41.2 | 76 | 270.9 | 52.7 |
| 37 | 36.3 | 7.1 | 97 | 95.2 | 18.5 | 57 | 154.1 | 30.0 | 17 | 213.0 | 41.4 | 77 | 271.9 | 52.9 |
| 38 | 37.3 | 7.3 | 98 | 96.2 | 18.7 | 58 | 155.1 | 30.1 | 18 | 214.0 | 41.6 | 78 | 272.9 | 53.0 |
| 39 | 38.3 | 7.4 | 99 | 97.2 | 18.9 | 59 | 156.1 | 30.3 | 19 | 215.0 | 41.8 | 79 | 273.9 | 53.2 |
| 40 | 39.3 | 7.6 | 100 | 98.2 | 19.1 | 60 | 157.1 | 30.5 | 20 | 216.0 | 42.0 | 80 | 274.9 | 53.4 |
| 41 | 40.2 | 7.8 | 101 | 99.1 | 19.3 | 161 | 158.0 | 30.7 | 221 | 216.9 | 42.2 | 281 | 275.8 | 53.6 |
| 42 | 41.2 | 8.0 | 02 | 100.1 | 19.5 | 62 | 159.0 | 30.9 | 22 | 217.9 | 42.4 | 82 | 276.8 | 53.8 |
| 43 | 42.2 | 8.2 | 03 | 101.1 | 19.7 | 63 | 160.0 | 31.1 | 23 | 218.9 | 42.6 | 83 | 277.8 | 54.0 |
| 44 | 43.2 | 8.4 | 04 | 102.1 | 19.8 | 64 | 161.0 | 31.3 | 24 | 219.9 | 42.7 | 84 | 278.8 | 54.2 |
| 45 | 44.2 | 8.6 | 05 | 103.1 | 20.0 | 65 | 162.0 | 31.5 | 25 | 220.9 | 42.9 | 85 | 279.8 | 54.4 |
| 46 | 45.2 | 8.8 | 06 | 104.1 | 20.2 | 66 | 163.0 | 31.7 | 26 | 221.8 | 43.1 | 86 | 280.7 | 54.6. |
| 47 | 46.1 | 9.0 | 07 | 105.0 | 20.4 | 67 | 163.9 | 31.9 | 27 | 222.8 | 43.3 | 87 | 281.7 | 54.8 |
| 48 | 47.1 | 9.2 | 08 | 106.0 | 20.6 | 68 | 164.9 | 32.1 | 28 | 223.8 | 43.5 | 88 | 282.7 | 55.0 |
| 49 | 48.1 | 9.3 | 09 | 107.0 | 20.8 | 69 | 165.9 | 32.2 | 29 | 224.8 | 43.7 | 89 | 283.7 | 55.1 |
| 50 | 49.1 | 9.5 | 10 | 108.0 | 21.0 | 70 | 166.9 | 32.4 | 30 | 225.8 | 43.9 | 90 | 284.7 | 55.3 |
| 51 | 50.1 | 9.7 | 111 | 109.0 | 21.2 | 171 | 167.9 | 32.6 | 231 | 226.8 | 44.1 | 291 | 285.7 | 55.5 |
| 52 | 51.0 | 9.9 | 12 | 109.9 | 21.4 | 72 | 168.8 | 32.8 | 32 | 227.7 | 44.3 | 92 | 286 6 | 55.7 |
| 53 | 52.0 | 10.1 | 13 | 110.9 | 21.6 | 73 | 169.8 | 33.0 | 33 | 228.7 | 44.5 | 93 | 287.6 | 55.9 |
| 54 | 53.0 | 10.3 | 14 | 111.9 | 21.8 | 74 | 170.8 | 33.2 | 34 | 229.7 | 44.6 | 94 | 288.6 | 56.1 |
| 55 | 54.0 | 10.5 | 15 | 112.9 | 21.9 | 75 | 171.8 | 33.4 | 35 | 230.7 | 44.8 | 95 | 289.6 | 56.3 |
| 56 | 55.0 | 10.7 | 16 | 113.9 | 22.1 | 76 | 172.8 | 33.6 | 36 | 231.7 | 45.0 | 96 | 290.6 | 56.5 |
| 57 | 56.0 | 10.9 | 17 | 114.9 | 22.3 | 77 | 173.7 | 33.8 | 37 | 232.6 | 45.2 | 97 | 291.5 | 56.7 |
| 58 | 56.9 | 11.1 | 18 | 115.8 | 22.5 | 78 | 174.7 | 34.0 | 38 | 233.6 | 45.4 | 98 | 292.5 | 56.9 |
| 59 | 57.9 | 11.3 | 19 | 116.8 | 22.7 | 79 | 175.7 | 34.2 | 39 | 234.6 | 45.6 | 99 | 293.5 | 57.1 |
| 60 | 58.9 | 11.4 | 20 | 117.8 | 22.9 | 80 | 176.7 | 34.3 | 40 | 235.6 | 45.8 | 300 | 294.5 | 57.2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

79° (101°, 259°, 281°).

TABLE 2. [Page 389

Difference of Latitude and Departure for 11° (169°, 191°, 349°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 295.4 | 57.4 | 361 | 354.3 | 68.9 | 421 | 413.2 | 80.3 | 481 | 472.1 | 91.8 | 541 | 531.0 | 103.2 |
| 02 | 296.4 | 57.6 | 62 | 355.3 | 69.1 | 22 | 414.2 | 80.5 | 82 | 473.1 | 92.0 | 42 | 532.0 | 103.4 |
| 03 | 297.4 | 57.8 | 63 | 356.3 | 69.3 | 23 | 415.2 | 80.7 | 83 | 474.1 | 92.2 | 43 | 533.0 | 103.6 |
| 04 | 298.4 | 58.0 | 64 | 357.3 | 69.5 | 24 | 416.2 | 80.9 | 84 | 475.1 | 92.4 | 44 | 534.0 | 103.8 |
| 05 | 299.4 | 58.2 | 65 | 358.3 | 69.6 | 25 | 417.2 | 81.1 | 85 | 476.1 | 92.6 | 45 | 535.0 | 104.0 |
| 06 | 300.3 | 58.4 | 66 | 359.2 | 69.8 | 26 | 418.1 | 81.3 | 86 | 477.0 | 92.8 | 46 | 535.9 | 104.2 |
| 07 | 301.3 | 58.6 | 67 | 360.2 | 70.0 | 27 | 419.1 | 81.5 | 87 | 478.0 | 93.0 | 47 | 536.9 | 104.4 |
| 08 | 302.3 | 58.8 | 68 | 361.2 | 70.2 | 28 | 420.1 | 81.7 | 88 | 479.0 | 93.2 | 48 | 537.9 | 104.6 |
| 09 | 303.3 | 59.0 | 69 | 362.2 | 70.4 | 29 | 421.1 | 81.9 | 89 | 480.0 | 93.3 | 49 | 538.9 | 104.8 |
| 10 | 304.3 | 59.2 | 70 | 363.2 | 70.6 | 30 | 422.1 | 82.1 | 90 | 481.0 | 93.5 | 50 | 539.9 | 105.0 |
| 311 | 305.3 | 59.3 | 371 | 364.1 | 70.8 | 431 | 423.0 | 82.2 | 491 | 481.9 | 93.6 | 551 | 540.8 | 105.1 |
| 12 | 306.2 | 59.5 | 72 | 365.1 | 71.0 | 32 | 424.0 | 82.4 | 92 | 482.9 | 93.8 | 52 | 541.8 | 105.3 |
| 13 | 307.2 | 59.7 | 73 | 366.1 | 71.2 | 33 | 425.0 | 82.6 | 93 | 483.9 | 94.0 | 53 | 542.8 | 105.5 |
| 14 | 308.2 | 59.9 | 74 | 367.1 | 71.4 | 34 | 426.0 | 82.8 | 94 | 484.9 | 94.2 | 54 | 543.8 | 105.7 |
| 15 | 309.2 | 60.1 | 75 | 368.1 | 71.6 | 35 | 427.0 | 83.0 | 95 | 485.9 | 94.4 | 55 | 544.8 | 105.9 |
| 16 | 310.2 | 60.3 | 76 | 369.1 | 71.7 | 36 | 428.0 | 83.2 | 96 | 486.9 | 94.6 | 56 | 545.8 | 106.1 |
| 17 | 311.1 | 60.5 | 77 | 370.0 | 71.9 | 37 | 428.9 | 83.4 | 97 | 487.8 | 94.8 | 57 | 546.7 | 106.3 |
| 18 | 312.1 | 60.7 | 78 | 371.0 | 72.1 | 38 | 429.9 | 83.6 | 98 | 488.8 | 95.0 | 58 | 547.7 | 106.5 |
| 19 | 313.1 | 60.9 | 79 | 372.0 | 72.3 | 39 | 430.9 | 83.8 | 99 | 489.8 | 95.2 | 59 | 548.7 | 106.7 |
| 20 | 314.1 | 61.1 | 80 | 373.0 | 72.5 | 40 | 431.9 | 84.0 | 500 | 490.8 | 95.4 | 60 | 549.7 | 106.9 |
| 321 | 315.1 | 61.3 | 381 | 374.0 | 72.7 | 441 | 432.9 | 84.1 | 501 | 491.8 | 95.6 | 561 | 550.7 | 107.1 |
| 22 | 316.1 | 61.4 | 82 | 374.9 | 72.9 | 42 | 433.8 | 84.3 | 02 | 492.7 | 95.8 | 62 | 551.6 | 107.2 |
| 23 | 317.0 | 61.6 | 83 | 375.9 | 73.1 | 43 | 434.8 | 84.5 | 03 | 493.7 | 96.0 | 63 | 552.6 | 107.4 |
| 24 | 318.0 | 61.8 | 84 | 376.9 | 73.3 | 44 | 435.8 | 84.7 | 04 | 494.7 | 96.2 | 64 | 553.6 | 107.6 |
| 25 | 319.0 | 62.0 | 85 | 377.9 | 73.5 | 45 | 436.8 | 84.9 | 05 | 495.7 | 96.4 | 65 | 554.6 | 107.8 |
| 26 | 320.0 | 62.2 | 86 | 378.9 | 73.7 | 46 | 437.8 | 85.1 | 06 | 496.7 | 96.6 | 66 | 555.6 | 108.0 |
| 27 | 321.0 | 62.4 | 87 | 379.9 | 73.8 | 47 | 438.8 | 85.3 | 07 | 497.7 | 96.8 | 67 | 556.6 | 108.2 |
| 28 | 321.9 | 62.6 | 88 | 380.8 | 74.0 | 48 | 439.7 | 85.5 | 08 | 498.6 | 97.0 | 68 | 557.6 | 108.4 |
| 29 | 322.9 | 62.8 | 89 | 381.8 | 74.2 | 49 | 440.7 | 85.7 | 09 | 499.6 | 97.2 | 69 | 558.6 | 108.6 |
| 30 | 323.9 | 63.0 | 90 | 382.8 | 74.4 | 50 | 441.7 | 85.9 | 10 | 500.6 | 97.3 | 70 | 559.5 | 108.8 |
| 331 | 324.9 | 63.2 | 391 | 383.8 | 74.6 | 451 | 442.7 | 86.1 | 511 | 501.6 | 97.5 | 571 | 560.5 | 109.0 |
| 32 | 325.9 | 63.4 | 92 | 384.8 | 74.8 | 52 | 443.7 | 86.2 | 12 | 502.6 | 97.6 | 72 | 561.5 | 109.1 |
| 33 | 326.8 | 63.5 | 93 | 385.7 | 75.0 | 53 | 444.6 | 86.4 | 13 | 503.5 | 97.8 | 73 | 562.5 | 109.3 |
| 34 | 327.8 | 63.7 | 94 | 386.7 | 75.2 | 54 | 445.6 | 86.6 | 14 | 504.5 | 98.0 | 74 | 563.5 | 109.5 |
| 35 | 328.8 | 63.9 | 95 | 387.7 | 75.4 | 55 | 446.6 | 86.8 | 15 | 505.5 | 98.2 | 75 | 564.5 | 109.7 |
| 36 | 329.8 | 64.1 | 96 | 388.7 | 75.6 | 56 | 447.6 | 87.0 | 16 | 506.5 | 98.4 | 76 | 565.4 | 109.9 |
| 37 | 330.8 | 64.3 | 97 | 389.7 | 75.8 | 57 | 448.6 | 87.2 | 17 | 507.5 | 98.6 | 77 | 566.4 | 110.1 |
| 38 | 331.8 | 64.5 | 98 | 390.7 | 75.9 | 58 | 449.6 | 87.4 | 18 | 508.5 | 98.8 | 78 | 567.4 | 110.3 |
| 39 | 332.7 | 64.7 | 99 | 391.6 | 76.1 | 59 | 450.5 | 87.6 | 19 | 509.4 | 99.0 | 79 | 568.3 | 110.5 |
| 40 | 333.7 | 64.9 | 400 | 392.6 | 76.3 | 60 | 451.5 | 87.8 | 20 | 510.4 | 99.2 | 80 | 569.3 | 110.7 |
| 341 | 334.7 | 65.1 | 401 | 393.6 | 76.5 | 461 | 452.5 | 88.0 | 521 | 511.4 | 99.4 | 581 | 570.3 | 110.9 |
| 42 | 335.7 | 65.3 | 02 | 394.6 | 76.7 | 62 | 453.5 | 88.2 | 22 | 512.4 | 99.6 | 82 | 571.3 | 111.1 |
| 43 | 336.7 | 65.5 | 03 | 395.6 | 76.9 | 63 | 454.5 | 88.3 | 23 | 513.4 | 99.8 | 83 | 572.3 | 111.3 |
| 44 | 337.6 | 65.6 | 04 | 396.5 | 77.1 | 64 | 455.4 | 88.5 | 24 | 514.3 | 100.0 | 84 | 573.2 | 111.5 |
| 45 | 338.6 | 65.8 | 05 | 397.5 | 77.3 | 65 | 456.4 | 88.7 | 25 | 515.3 | 100.2 | 85 | 574.2 | 111.7 |
| 46 | 339.6 | 66.0 | 06 | 398.5 | 77.5 | 66 | 457.4 | 88.9 | 26 | 516.3 | 100.4 | 86 | 575.2 | 111.8 |
| 47 | 340.6 | 66.2 | 07 | 399.5 | 77.7 | 67 | 458.4 | 89.1 | 27 | 517.3 | 100.6 | 87 | 576.2 | 112.1 |
| 48 | 341.6 | 66.4 | 08 | 400.5 | 77.9 | 68 | 459.4 | 89.3 | 28 | 518.3 | 100.8 | 88 | 577.2 | 112.3 |
| 49 | 342.6 | 66.6 | 09 | 401.5 | 78.1 | 69 | 460.4 | 89.5 | 29 | 519.3 | 101.0 | 89 | 578.2 | 112.4 |
| 50 | 343.5 | 66.8 | 10 | 402.4 | 78.2 | 70 | 461.3 | 89.7 | 30 | 520.2 | 101.2 | 90 | 579.1 | 112.6 |
| 351 | 344.5 | 67.0 | 411 | 403.4 | 78.4 | 471 | 462.3 | 89.9 | 531 | 521.2 | 101.4 | 591 | 580.1 | 112.8 |
| 52 | 345.5 | 67.2 | 12 | 404.4 | 78.6 | 72 | 463.3 | 90.1 | 32 | 522.2 | 101.6 | 92 | 581.1 | 113.0 |
| 53 | 346.5 | 67.4 | 13 | 405.4 | 78.8 | 73 | 464.3 | 90.3 | 33 | 523.2 | 101.7 | 93 | 582.1 | 113.2 |
| 54 | 347.5 | 67.5 | 14 | 406.4 | 79.0 | 74 | 465.3 | 90.4 | 34 | 524.2 | 101.8 | 94 | 583.1 | 113.3 |
| 55 | 348.4 | 67.7 | 15 | 407.3 | 79.2 | 75 | 466.2 | 90.6 | 35 | 525.1 | 102.0 | 95 | 584.0 | 113.5 |
| 56 | 349.4 | 67.9 | 16 | 408.3 | 79.4 | 76 | 467.2 | 90.8 | 36 | 526.1 | 102.2 | 96 | 585.0 | 113.7 |
| 57 | 350.4 | 68.1 | 17 | 409.3 | 79.6 | 77 | 468.2 | 91.0 | 37 | 527.1 | 102.4 | 97 | 586.0 | 113.9 |
| 58 | 351.4 | 68.3 | 18 | 410.3 | 79.8 | 78 | 469.2 | 91.2 | 38 | 528.1 | 102.6 | 98 | 587.0 | 114.1 |
| 59 | 352.4 | 68.5 | 19 | 411.3 | 80.0 | 79 | 470.2 | 91.4 | 39 | 529.1 | 102.8 | 99 | 588.0 | 114.3 |
| 60 | 353.4 | 68.7 | 20 | 412.3 | 80.1 | 80 | 471.1 | 91.6 | 40 | 530.1 | 103.0 | 600 | 589.0 | 114.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

79° (101°, 259°, 281°).

# TABLE 2.

Difference of Latitude and Departure for 12° (168°, 192°, 348°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 59.7 | 12.7 | 121 | 118.4 | 25.2 | 181 | 177.0 | 37.6 | 241 | 235.7 | 50.1 |
| 2 | 2.0 | 0.4 | 62 | 60.6 | 12.9 | 22 | 119.3 | 25.4 | 82 | 178.0 | 37.8 | 42 | 236.7 | 50.3 |
| 3 | 2.9 | 0.6 | 63 | 61.6 | 13.1 | 23 | 120.3 | 25.6 | 83 | 179.0 | 38.0 | 43 | 237.7 | 50.5 |
| 4 | 3.9 | 0.8 | 64 | 62.6 | 13.3 | 24 | 121.3 | 25.8 | 84 | 180.0 | 38.3 | 44 | 238.7 | 50.7 |
| 5 | 4.9 | 1.0 | 65 | 63.6 | 13.5 | 25 | 122.3 | 26.0 | 85 | 181.0 | 38.5 | 45 | 239.6 | 50.9 |
| 6 | 5.9· | 1.2 | 66 | 64.6 | 13.7 | 26 | 123.2 | 26.2 | 86 | 181.9 | 38.7 | 46 | 240.6 | 51.1 |
| 7 | 6.8 | 1.5 | 67 | 65.5 | 13.9 | 27 | 124.2 | 26.4 | 87 | 182.9 | 38.9 | 47 | 241.6 | 51.4 |
| 8 | 7.8 | 1.7 | 68 | 66.5 | 14.1 | 28 | 125.2 | 26.6 | 88 | 183.9 | 39.1 | 48 | 242.6 | 51.6 |
| 9 | 8.8 | 1.9 | 69 | 67.5 | 14.3 | 29 | 126.2 | 26.8 | 89 | 184.9 | 39.3 | 49 | 243.6 | 51.8 |
| 10 | 9.8 | 2.1 | 70 | 68.5 | 14.6 | 30 | 127.2 | 27.0 | 90 | 185.8 | 39.5 | 50 | 244.5 | 52.0 |
| 11 | 10.8 | 2.3 | 71 | 69.4 | 14.8 | 131 | 128.1 | 27.2 | 191 | 186.8 | 39.7 | 251 | 245.5 | 52.2 |
| 12 | 11.7 | 2.5 | 72 | 70.4 | 15.0 | 32 | 129.1 | 27.4 | 92 | 187.8 | 39.9 | 52 | 246.5 | 52.4 |
| 13 | 12.7 | 2.7 | 73 | 71.4 | 15.2 | 33 | 130.1 | 27.7 | 93 | 188.8 | 40.1 | 53 | 247.5 | 52.6 |
| 14 | 13.7 | 2.9 | 74 | 72.4 | 15.4 | 34 | 131.1 | 27.9 | 94 | 189.8 | 40.3 | 54 | 248.4 | 52.8 |
| 15 | 14.7 | 3.1 | 75 | 73.4 | 15.6 | 35 | 132.0 | 28.1 | 95 | 190.7 | 40.5 | 55 | 249.4 | 53.0 |
| 16 | 15.7 | 3.3 | 76 | 74.3 | 15.8 | 36 | 133.0 | 28.3 | 96 | 191.7 | 40.8 | 56 | 250.4 | 53.2 |
| 17 | 16.6 | 3.5 | 77 | 75.3 | 16.0 | 37 | 134.0 | 28.5 | 97 | 192.7 | 41.0 | 57 | 251.4 | 53.4 |
| 18 | 17.6 | 3.7 | 78 | 76.3 | 16.2 | 38 | 135.0 | 28.7 | 98 | 193.7 | 41.2 | 58 | 252.4 | 53.6 |
| 19 | 18.6 | 4.0 | 79 | 77.3 | 16.4 | 39 | 136.0 | 28.9 | 99 | 194.7 | 41.4 | 59 | 253.3 | 53.8 |
| 20 | 19.6 | 4.2 | 80 | 78.3 | 16.6 | 40 | 136.9 | 29.1 | 200 | 195.6 | 41.6 | 60 | 254.3 | 54.1 |
| 21 | 20.5 | 4.4 | 81 | 79.2 | 16.8 | 141 | 137.9 | 29.3 | 201 | 196.6 | 41.8 | 261 | 255.3 | 54.3 |
| 22 | 21.5 | 4.6 | 82 | 80.2 | 17.0 | 42 | 138.9 | 29.5 | 02 | 197.6 | 42.0 | 62 | 256.3 | 54.5 |
| 23 | 22.5 | 4.8 | 83 | 81.2 | 17.3 | 43 | 139.9 | 29.7 | 03 | 198.6 | 42.2 | 63 | 257.3 | 54.7 |
| 24 | 23.5 | 5.0 | 84 | 82.2 | 17.5 | 44 | 140.9 | 29.9 | 04 | 199.5 | 42.4 | 64 | 258.2 | 54.9 |
| 25 | 24.5 | 5.2 | 85 | 83.1 | 17.7 | 45 | 141.8 | 30.1 | 05 | 200.5 | 42.6 | 65 | 259.2 | 55.1 |
| 26 | 25.4 | 5.4 | 86 | 84.1 | 17.9 | 46 | 142.8 | 30.4 | 06 | 201.5 | 42.8 | 66 | 260.2 | 55.3 |
| 27 | 26.4 | 5.6 | 87 | 85.1 | 18.1 | 47 | 143.8 | 30.6 | 07 | 202.5 | 43.0 | 67 | 261.2 | 55.5 |
| 28 | 27.4 | 5.8 | 88 | 86.1 | 18.3 | 48 | 144.8 | 30.8 | 08 | 203.5 | 43.2 | 68 | 262.1 | 55.7 |
| 29 | 28.4 | 6.0 | 89 | 87.1 | 18.5 | 49 | 145.7 | 31.0 | 09 | 204.4 | 43.5 | 69 | 263.1 | 55.9 |
| 30 | 29.3 | 6.2 | 90 | 88.0 | 18.7 | 50 | 146.7 | 31.2 | 10 | 205.4 | 43.7 | 70 | 264.1 | 56.1 |
| 31 | 30.3 | 6.4 | 91 | 89.0 | 18.9 | 151 | 147.7 | 31.4 | 211 | 206.4 | 43.9 | 271 | 265.1 | 56.3 |
| 32 | 31.3 | 6.7 | 92 | 90.0 | 19.1 | 52 | 148.7 | 31.6 | 12 | 207.4 | 44.1 | 72 | 266.1 | 56.6 |
| 33 | 32.3 | 6.9 | 93 | 91.0 | 19.3 | 53 | 149.7 | 31.8 | 13 | 208.3 | 44.3 | 73 | 267.0 | 56.8 |
| 34 | 33.3 | 7.1 | 94 | 91.9 | 19.5 | 54 | 150.6 | 32.0 | 14 | 209.3 | 44.5 | 74 | 268.0 | 57.0 |
| 35 | 34.2 | 7.3 | 95 | 92.9 | 19.8 | 55 | 151.6 | 32.2 | 15 | 210.3 | 44.7 | 75 | 269.0 | 57.2 |
| 36 | 35.2 | 7.5 | 96 | 93.9 | 20.0 | 56 | 152.6 | 32.4 | 16 | 211.3 | 44.9 | 76 | 270.0 | 57.4 |
| 37 | 36.2 | 7.7 | 97 | 94.9 | 20.2 | 57 | 153.6 | 32.6 | 17 | 212.3 | 45.1 | 77 | 270.9 | 57.6 |
| 38 | 37.2 | 7.9 | 98 | 95.9 | 20.4 | 58 | 154.5 | 32.9 | 18 | 213.2 | 45.3 | 78 | 271.9 | 57.8 |
| 39 | 38.1 | 8.1 | 99 | 96.8 | 20.6 | 59 | 155.5 | 33.1 | 19 | 214.2 | 45.5 | 79 | 272.9 | 58.0 |
| 40 | 39.1 | 8.3 | 100 | 97.8 | 20.8 | 60 | 156.5 | 33.3 | 20 | 215.2 | 45.7 | 80 | 273.9 | 58.2 |
| 41 | 40.1 | 8.5 | 101 | 98.8 | 21.0 | 161 | 157.5 | 33.5 | 221 | 216.2 | 45.9 | 281 | 274.9 | 58.4 |
| 42 | 41.1 | 8.7 | 02 | 99.8 | 21.2 | 62 | 158.5 | 33.7 | 22 | 217.1 | 46.2 | 82 | 275.8 | 58.6 |
| 43 | 42.1 | 8.9 | 03 | 100.7 | 21.4 | 63 | 159.4 | 33.9 | 23 | 218.1 | 46.4 | 83 | 276.8 | 58.8 |
| 44 | 43.0 | 9.1 | 04 | 101.7 | 21.6 | 64 | 160.4 | 34.1 | 24 | 219.1 | 46.6 | 84 | 277.8 | 59.0 |
| 45 | 44.0 | 9.4 | 05 | 102.7 | 21.8 | 65 | 161.4 | 34.3 | 25 | 220.1 | 46.8 | 85 | 278.8 | 59.3 |
| 46 | 45.0 | 9.6 | 06 | 103.7 | 22.0 | 66 | 162.4 | 34.5 | 26 | 221.1 | 47.0 | 86 | 279.8 | 59.5 |
| 47 | 46.0 | 9.8 | 07 | 104.7 | 22.2 | 67 | 163.4 | 34.7 | 27 | 222.0 | 47.2 | 87 | 280.7 | 59.7 |
| 48 | 47.0 | 10.0 | 08 | 105.7 | 22.5 | 68 | 164.3 | 34.9 | 28 | 223.0 | 47.4 | 88 | 281.7 | 59.9 |
| 49 | 47.9 | 10.2 | 09 | 106.6 | 22.7 | 69 | 165.3 | 35.1 | 29 | 224.0 | 47.6 | 89 | 282.7 | 60.1 |
| 50 | 48.9 | 10.4 | 10 | 107.6 | 22.9 | 70 | 166.3 | 35.3 | 30 | 225.0 | 47.8 | 90 | 283.7 | 60.3 |
| 51 | 49.9 | 10.6 | 111 | 108.6 | 23.1 | 171 | 167.3 | 35.6 | 231 | 226.0 | 48.0 | 291 | 284.6 | 60.5 |
| 52 | 50.9 | 10.8 | 12 | 109.6 | 23.3 | 72 | 168.2 | 35.8 | 32 | 226.9 | 48.2 | 92 | 285.6 | 60.7 |
| 53 | 51.8 | 11.0 | 13 | 110.5 | 23.5 | 73 | 169.2 | 36.0 | 33 | 227.9 | 48.4 | 93 | 286.6 | 60.9 |
| 54 | 52.8 | 11.2 | 14 | 111.5 | 23.7 | 74 | 170.2 | 36.2 | 34 | 228.9 | 48.7 | 94 | 287.6 | 61.1 |
| 55 | 53.8 | 11.4 | 15 | 112.5 | 23.9 | 75 | 171.2 | 36.4 | 35 | 229.9 | 48.9 | 95 | 288.6 | 61.3 |
| 56 | 54.8 | 11.6 | 16 | 113.5 | 24.1 | 76 | 172.2 | 36.6 | 36 | 230.8 | 49.1 | 96 | 289.5 | 61.5 |
| 57 | 55.8 | 11.9 | 17 | 114.4 | 24.3 | 77 | 173.1 | 36.8 | 37 | 231.8 | 49.3 | 97 | 290.5 | 61.7 |
| 58 | 56.7 | 12.1 | 18 | 115.4 | 24.5 | 78 | 174.1 | 37.0 | 38 | 232.8 | 49.5 | 98 | 291.5 | 62.0 |
| 59 | 57.7 | 12.3 | 19 | 116.4 | 24.7 | 79 | 175.1 | 37.2 | 39 | 233.8 | 49.7 | 99 | 292.5 | 62.2 |
| 60 | 58.7 | 12.5 | 20 | 117.4 | 24.9 | 80 | 176.1 | 37.4 | 40 | 234.8 | 49.9 | 300 | 293.4 | 62.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

78° (102°, 258°, 282°).

TABLE 2. [Page 391

Difference of Latitude and Departure for 12° (168°, 192°, 348°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 294.4 | 62.6 | 361 | 353.1 | 75.0 | 421 | 411.8 | 87.5 | 481 | 470.5 | 100.0 | 541 | 529.2 | 112.5 |
| 02 | 295.4 | 62.8 | 62 | 354.1 | 75.2 | 22 | 412.8 | 87.7 | 82 | 471.5 | 100.2 | 42 | 530.2 | 112.7 |
| 03 | 296.4 | 63.0 | 63 | 355.1 | 75.4 | 23 | 413.8 | 87.9 | 83 | 472.5 | 100.4 | 43 | 531.1 | 112.9 |
| 04 | 297.4 | 63.2 | 64 | 356.0 | 75.7 | 24 | 414.7 | 88.1 | 84 | 473.4 | 100.6 | 44 | 532.1 | 113.1 |
| 05 | 298.3 | 63.4 | 65 | 357.0 | 75.9 | 25 | 415.7 | 88.3 | 85 | 474.4 | 100.8 | 45 | 533.1 | 113.3 |
| 06 | 299.3 | 63.6 | 66 | 358.0 | 76.1 | 26 | 416.7 | 88.6 | 86 | 475.4 | 101.0 | 46 | 534.1 | 113.5 |
| 07 | 300.3 | 63.8 | 67 | 359.0 | 76.3 | 27 | 417.7 | 88.8 | 87 | 476.4 | 101.2 | 47 | 535.1 | 113.7 |
| 08 | 301.3 | 64.0 | 68 | 360.0 | 76.5 | 28 | 418.6 | 89.0 | 88 | 477.3 | 101.4 | 48 | 536.0 | 113.9 |
| 09 | 302.2 | 64.2 | 69 | 360.9 | 76.7 | 29 | 419.6 | 89.2 | 89 | 478.3 | 101.6 | 49 | 537.0 | 114.1 |
| 10 | 303.2 | 64.4 | 70 | 361.9 | 76.9 | 30 | 420.6 | 89.4 | 90 | 479.3 | 101.9 | 50 | 538.0 | 114.4 |
| 311 | 304.2 | 64.6 | 371 | 362.9 | 77.1 | 431 | 421.6 | 89.6 | 491 | 480.3 | 102.1 | 551 | 538.9 | 114.6 |
| 12 | 305.2 | 64.8 | 72 | 363.9 | 77.3 | 32 | 422.6 | 89.8 | 92 | 481.2 | 102.3 | 52 | 539.9 | 114.8 |
| 13 | 306.2 | 65.1 | 73 | 364.8 | 77.5 | 33 | 423.5 | 90.0 | 93 | 482.2 | 102.5 | 53 | 540.9 | 115.0 |
| 14 | 307.1 | 65.3 | 74 | 365.8 | 77.7 | 34 | 424.5 | 90.2 | 94 | 483.2 | 102.7 | 54 | 541.9 | 115.2 |
| 15 | 308.1 | 65.5 | 75 | 366.8 | 77.9 | 35 | 425.5 | 90.4 | 95 | 484.2 | 102.9 | 55 | 542.9 | 115.4 |
| 16 | 309.1 | 65.7 | 76 | 367.8 | 78.2 | 36 | 426.5 | 90.6 | 96 | 485.2 | 103.1 | 56 | 543.8 | 115.6 |
| 17 | 310.1 | 65.9 | 77 | 368.8 | 78.4 | 37 | 427.5 | 90.8 | 97 | 486.1 | 103.3 | 57 | 544.8 | 115.8 |
| 18 | 311.1 | 66.1 | 78 | 369.7 | 78.6 | 38 | 428.4 | 91.0 | 98 | 487.1 | 103.5 | 58 | 545.8 | 116.0 |
| 19 | 312.0 | 66.3 | 79 | 370.7 | 78.8 | 39 | 429.4 | 91.3 | 99 | 488.1 | 103.8 | 59 | 546.8 | 116.2 |
| 20 | 313.0 | 66.5 | 80 | 371.7 | 79.0 | 40 | 430.4 | 91.5 | 500 | 489.1 | 104.0 | 60 | 547.8 | 116.4 |
| 321 | 314.0 | 66.7 | 381 | 372.7 | 79.2 | 441 | 431.4 | 91.7 | 501 | 490.0 | 104.2 | 561 | 548.7 | 116.6 |
| 22 | 315.0 | 66.9 | 82 | 373.7 | 79.4 | 42 | 432.3 | 91.9 | 02 | 491.0 | 104.4 | 62 | 549.7 | 116.8 |
| 23 | 315.9 | 67.1 | 83 | 374.6 | 79.6 | 43 | 433.3 | 92.1 | 03 | 492.0 | 104.6 | 63 | 550.7 | 117.0 |
| 24 | 316.9 | 67.3 | 84 | 375.6 | 79.8 | 44 | 434.3 | 92.3 | 04 | 493.0 | 104.8 | 64 | 551.7 | 117.2 |
| 25 | 317.9 | 67.6 | 85 | 376.6 | 80.0 | 45 | 435.3 | 92.5 | 05 | 494.0 | 105.0 | 65 | 552.7 | 117.4 |
| 26 | 318.9 | 67.8 | 86 | 377.6 | 80.2 | 46 | 436.3 | 92.7 | 06 | 495.0 | 105.2 | 66 | 553.7 | 117.6 |
| 27 | 319.9 | 68.0 | 87 | 378.5 | 80.4 | 47 | 437.2 | 92.9 | 07 | 495.9 | 105.4 | 67 | 554.6 | 117.8 |
| 28 | 320.8 | 68.2 | 88 | 379.5 | 80.7 | 48 | 438.2 | 93.1 | 08 | 496.9 | 105.6 | 68 | 555.6 | 118.0 |
| 29 | 321.8 | 68.4 | 89 | 380.5 | 80.9 | 49 | 439.2 | 93.3 | 09 | 497.9 | 105.8 | 69 | 556.6 | 118.2 |
| 30 | 322.8 | 68.6 | 90 | 381.5 | 81.1 | 50 | 440.2 | 93.5 | 10 | 498.9 | 106.0 | 70 | 557.5 | 118.5 |
| 331 | 323.8 | 68.8 | 391 | 382.5 | 81.3 | 451 | 441.1 | 93.7 | 511 | 499.8 | 106.2 | 571 | 558.5 | 118.7 |
| 32 | 324.7 | 69.0 | 92 | 383.4 | 81.5 | 52 | 442.1 | 93.9 | 12 | 500.8 | 106.4 | 72 | 559.5 | 118.9 |
| 33 | 325.7 | 69.2 | 93 | 384.4 | 81.7 | 53 | 443.1 | 94.1 | 13 | 501.8 | 106.6 | 73 | 560.5 | 119.1 |
| 34 | 326.7 | 69.4 | 94 | 385.4 | 81.9 | 54 | 444.1 | 94.4 | 14 | 502.8 | 106.8 | 74 | 561.5 | 119.3 |
| 35 | 327.7 | 69.6 | 95 | 386.4 | 82.1 | 55 | 445.1 | 94.6 | 15 | 503.7 | 107.0 | 75 | 562.4 | 119.5 |
| 36 | 328.7 | 69.8 | 96 | 387.3 | 82.3 | 56 | 446.0 | 94.8 | 16 | 504.7 | 107.2 | 76 | 563.4 | 119.7 |
| 37 | 329.6 | 70.0 | 97 | 388.3 | 82.5 | 57 | 447.0 | 95.0 | 17 | 505.7 | 107.4 | 77 | 564.4 | 119.9 |
| 38 | 330.6 | 70.3 | 98 | 389.3 | 82.7 | 58 | 448.0 | 95.2 | 18 | 506.7 | 107.6 | 78 | 565.4 | 120.1 |
| 39 | 331.6 | 70.5 | 99 | 390.3 | 82.9 | 59 | 449.0 | 95.4 | 19 | 507.7 | 107.8 | 79 | 566.4 | 120.3 |
| 40 | 332.6 | 70.7 | 400 | 391.3 | 83.1 | 60 | 450.0 | 95.6 | 20 | 508.7 | 108.1 | 80 | 567.4 | 120.6 |
| 341 | 333.5 | 70.9 | 401 | 392.2 | 83.4 | 461 | 450.9 | 95.8 | 521 | 509.6 | 108.3 | 581 | 568.3 | 120.8 |
| 42 | 334.5 | 71.1 | 02 | 393.2 | 83.6 | 62 | 451.9 | 96.0 | 22 | 510.6 | 108.5 | 82 | 569.3 | 121.0 |
| 43 | 335.5 | 71.3 | 03 | 394.2 | 83.8 | 63 | 452.9 | 96.2 | 23 | 511.6 | 108.7 | 83 | 570.3 | 121.2 |
| 44 | 336.5 | 71.5 | 04 | 395.2 | 84.0 | 64 | 453.9 | 96.5 | 24 | 512.5 | 108.9 | 84 | 571.2 | 121.4 |
| 45 | 337.5 | 71.7 | 05 | 396.2 | 84.2 | 65 | 454.8 | 96.7 | 25 | 513.5 | 109.2 | 85 | 572.2 | 121.6 |
| 46 | 338.4 | 71.9 | 06 | 397.1 | 84.4 | 66 | 455.8 | 96.9 | 26 | 514.5 | 109.4 | 86 | 573.2 | 121.8 |
| 47 | 339.4 | 72.1 | 07 | 398.1 | 84.6 | 67 | 456.8 | 97.1 | 27 | 515.5 | 109.6 | 87 | 574.2 | 122.0 |
| 48 | 340.4 | 72.3 | 08 | 399.1 | 84.8 | 68 | 457.8 | 97.3 | 28 | 516.5 | 109.8 | 88 | 575.2 | 122.2 |
| 49 | 341.4 | 72.5 | 09 | 400.1 | 85.0 | 69 | 458.8 | 97.5 | 29 | 517.5 | 110.0 | 89 | 576.2 | 122.4 |
| 50 | 342.4 | 72.7 | 10 | 401.0 | 85.2 | 70 | 459.7 | 97.7 | 30 | 518.4 | 110.2 | 90 | 577.1 | 122.6 |
| 351 | 343.3 | 73.0 | 411 | 402.0 | 85.4 | 471 | 460.7 | 97.9 | 531 | 519.4 | 110.4 | 591 | 578.1 | 122.8 |
| 52 | 344.3 | 73.2 | 12 | 403.0 | 85.6 | 72 | 461.7 | 98.1 | 32 | 520.4 | 110.6 | 92 | 579.1 | 123.0 |
| 53 | 345.3 | 73.4 | 13 | 404.0 | 85.8 | 73 | 462.7 | 98.3 | 33 | 521.3 | 110.8 | 93 | 580.0 | 123.2 |
| 54 | 346.3 | 73.6 | 14 | 405.0 | 86.1 | 74 | 463.6 | 98.5 | 34 | 522.3 | 111.0 | 94 | 581.0 | 123.4 |
| 55 | 347.2 | 73.8 | 15 | 405.9 | 86.3 | 75 | 464.6 | 98.7 | 35 | 523.3 | 111.2 | 95 | 582.0 | 123.6 |
| 56 | 348.2 | 74.0 | 16 | 406.9 | 86.5 | 76 | 465.6 | 98.9 | 36 | 524.3 | 111.4 | 96 | 583.0 | 123.9 |
| 57 | 349.2 | 74.2 | 17 | 407.9 | 86.7 | 77 | 466.6 | 99.1 | 37 | 525.3 | 111.6 | 97 | 584.0 | 124.1 |
| 58 | 350.2 | 74.4 | 18 | 408.9 | 86.9 | 78 | 467.6 | 99.4 | 38 | 526.2 | 111.8 | 98 | 584.9 | 124.3 |
| 59 | 351.2 | 74.6 | 19 | 409.8 | 87.1 | 79 | 468.5 | 99.6 | 39 | 527.2 | 112.0 | 99 | 585.9 | 124.5 |
| 60 | 352.1 | 74.8 | 20 | 410.8 | 87.3 | 80 | 469.5 | 99.8 | 40 | 528.2 | 112.3 | 600 | 586.9 | 124.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

78° (102°, 258°, 282°).

# TABLE 2.

### Difference of Latitude and Departure for 13° (167°, 193°, 347°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 59.4 | 13.7 | 121 | 117.9 | 27.2 | 181 | 176.4 | 40.7 | 241 | 234.8 | 54.2 |
| 2 | 1.9 | 0.4 | 62 | 60.4 | 13.9 | 22 | 118.9 | 27.4 | 82 | 177.3 | 40.9 | 42 | 235.8 | 54.4 |
| 3 | 2.9 | 0.7 | 63 | 61.4 | 14.2 | 23 | 119.8 | 27.7 | 83 | 178.3 | 41.2 | 43 | 236.8 | 54.7 |
| 4 | 3.9 | 0.9 | 64 | 62.4 | 14.4 | 24 | 120.8 | 27.9 | 84 | 179.3 | 41.4 | 44 | 237.7 | 54.9 |
| 5 | 4.9 | 1.1 | 65 | 63.3 | 14.6 | 25 | 121.8 | 28.1 | 85 | 180.3 | 41.6 | 45 | 238.7 | 55.1 |
| 6 | 5.8 | 1.3 | 66 | 64.3 | 14.8 | 26 | 122.8 | 28.3 | 86 | 181.2 | 41.8 | 46 | 239.7 | 55.3 |
| 7 | 6.8 | 1.6 | 67 | 65.3 | 15.1 | 27 | 123.7 | 28.6 | 87 | 182.2 | 42.1 | 47 | 240.7 | 55.6 |
| 8 | 7.8 | 1.8 | 68 | 66.3 | 15.3 | 28 | 124.7 | 28.8 | 88 | 183.2 | 42.3 | 48 | 241.6 | 55.8 |
| 9 | 8.8 | 2.0 | 69 | 67.2 | 15.5 | 29 | 125.7 | 29.0 | 89 | 184.2 | 42.5 | 49 | 242.6 | 56.0 |
| 10 | 9.7 | 2.2 | 70 | 68.2 | 15.7 | 30 | 126.7 | 29.2 | 90 | 185.1 | 42.7 | 50 | 243.6 | 56.2 |
| 11 | 10.7 | 2.5 | 71 | 69.2 | 16.0 | 131 | 127.6 | 29.5 | 191 | 186.1 | 43.0 | 251 | 244.6 | 56.5 |
| 12 | 11.7 | 2.7 | 72 | 70.2 | 16.2 | 32 | 128.6 | 29.7 | 92 | 187.1 | 43.2 | 52 | 245.5 | 56.7 |
| 13 | 12.7 | 2.9 | 73 | 71.1 | 16.4 | 33 | 129.6 | 29.9 | 93 | 188.1 | 43.4 | 53 | 246.5 | 56.9 |
| 14 | 13.6 | 3.1 | 74 | 72.1 | 16.6 | 34 | 130.6 | 30.1 | 94 | 189.0 | 43.6 | 54 | 247.5 | 57.1 |
| 15 | 14.6 | 3.4 | 75 | 73.1 | 16.9 | 35 | 131.5 | 30.4 | 95 | 190.0 | 43.9 | 55 | 248.5 | 57.4 |
| 16 | 15.6 | 3.6 | 76 | 74.1 | 17.1 | 36 | 132.5 | 30.6 | 96 | 191.0 | 44.1 | 56 | 249.4 | 57.6 |
| 17 | 16.6 | 3.8 | 77 | 75.0 | 17.3 | 37 | 133.5 | 30.8 | 97 | 192.0 | 44.3 | 57 | 250.4 | 57.8 |
| 18 | 17.5 | 4.0 | 78 | 76.0 | 17.5 | 38 | 134.5 | 31.0 | 98 | 192.9 | 44.5 | 58 | 251.4 | 58.0 |
| 19 | 18.5 | 4.3 | 79 | 77.0 | 17.8 | 39 | 135.4 | 31.3 | 99 | 193.9 | 44.8 | 59 | 252.4 | 58.3 |
| 20 | 19.5 | 4.5 | 80 | 77.9 | 18.0 | 40 | 136.4 | 31.5 | 200 | 194.9 | 45.0 | 60 | 253.3 | 58.5 |
| 21 | 20.5 | 4.7 | 81 | 78.9 | 18.2 | 141 | 137.4 | 31.7 | 201 | 195.8 | 45.2 | 261 | 254.3 | 58.7 |
| .22 | 21.4 | 4.9 | 82 | 79.9 | 18.4 | 42 | 138.4 | 31.9 | 02 | 196.8 | 45.4 | 62 | 255.3 | 58.9 |
| 23 | 22.4 | 5.2 | 83 | 80.9 | 18.7 | 43 | 139.3 | 32.2 | 03 | 197.8 | 45.7 | 63 | 256.3 | 59.2 |
| 24 | 23.4 | 5.4 | 84 | 81.8 | 18.9 | 44 | 140.3 | 32.4 | 04 | 198.8 | 45.9 | 64 | 257.2 | 59.4 |
| 25 | 24.4 | 5.6 | 85 | 82.8 | 19.1 | 45 | 141.3 | 32.6 | 05 | 199.7 | 46.1 | 65 | 258.2 | 59.6 |
| 26 | 25.3 | 5.8 | 86 | 83.8 | 19.3 | 46 | 142.3 | 32.8 | 06 | 200.7 | 46.3 | 66 | 259.2 | 59.8 |
| 27 | 26.3 | 6.1 | 87 | 84.8 | 19.6 | 47 | 143.2 | 33.1 | 07 | 201.7 | 46.6 | 67 | 260.2 | 60.1 |
| 28 | 27.3 | 6.3 | 88 | 85.7 | 19.8 | 48 | 144.2 | 33.3 | 08 | 202.7 | 46.8 | 68 | 261.1 | 60.3 |
| 29 | 28.3 | 6.5 | 89 | 86.7 | 20.0 | 49 | 145.2 | 33.5 | 09 | 203.6 | 47.0 | 69 | 262.1 | 60.5 |
| 30 | 29.2 | 6.7 | 90 | 87.7 | 20.2 | 50 | 146.2 | 33.7 | 10 | 204.6 | 47.2 | 70 | 263.1 | 60.7 |
| 31 | 30.2 | 7.0 | 91 | 88.7 | 20.5 | 151 | 147.1 | 34.0 | 211 | 205.6 | 47.5 | 271 | 264.1 | 61.0 |
| 32 | 31.2 | 7.2 | 92 | 89.6 | 20.7 | 52 | 148.1 | 34.2 | 12 | 206.6 | 47.7 | 72 | 265.0 | 61.2 |
| 33 | 32.2 | 7.4 | 93 | 90.6 | 20.9 | 53 | 149.1 | 34.4 | 13 | 207.5 | 47.9 | 73 | 266.0 | 61.4 |
| 34 | 33.1 | 7.6 | 94 | 91.6 | 21.1 | 54 | 150.1 | 34.6 | 14 | 208.5 | 48.1 | 74 | 267.0 | 61.6 |
| 35 | 34.1 | 7.9 | 95 | 92.6 | 21.4 | 55 | 151.0 | 34.9 | 15 | 209.5 | 48.4 | 75 | 268.0 | 61.9 |
| 36 | 35.1 | 8.1 | 96 | 93.5 | 21.6 | 56 | 152.0 | 35.1 | 16 | 210.5 | 48.6 | 76 | 268.9 | 62.1 |
| 37 | 36.1 | 8.3 | 97 | 94.5 | 21.8 | 57 | 153.0 | 35.3 | 17 | 211.4 | 48.8 | 77 | 269.9 | 62.3 |
| 38 | 37.0 | 8.5 | 98 | 95.5 | 22.0 | 58 | 154.0 | 35.5 | 18 | 212.4 | 49.0 | 78 | 270.9 | 62.5 |
| 39 | 38.0 | 8.8 | 99 | 96.5 | 22.3 | 59 | 154.9 | 35.8 | 19 | 213.4 | 49.3 | 79 | 271.8 | 62.8 |
| 40 | 39.0 | 9.0 | 100 | 97.4 | 22.5 | 60 | 155.9 | 36.0 | 20 | 214.4 | 49.5 | 80 | 272.8 | 63.0 |
| 41 | 39.9 | 9.2 | 101 | 98.4 | 22.7 | 161 | 156.9 | 36.2 | 221 | 215.3 | 49.7 | 281 | 273.8 | 63.2 |
| 42 | 40.9 | 9.4 | 02 | 99.4 | 22.9 | 62 | 157.8 | 36.4 | 22 | 216.3 | 49.9 | 82 | 274.8 | 63.4 |
| 43 | 41.9 | 9.7 | 03 | 100.4 | 23.2 | 63 | 158.8 | 36.7 | 23 | 217.3 | 50.2 | 83 | 275.7 | 63.7 |
| 44 | 42.9 | 9.9 | 04 | 101.3 | 23.4 | 64 | 159.8 | 36.9 | 24 | 218.3 | 50.4 | 84 | 276.7 | 63.9 |
| 45 | 43.8 | 10.1 | 05 | 102.3 | 23.6 | 65 | 160.8 | 37.1 | 25 | 219.2 | 50.6 | 85 | 277.7 | 64.1 |
| 46 | 44.8 | 10.3 | 06 | 103.3 | 23.8 | 66 | 161.7 | 37.3 | 26 | 220.2 | 50.8 | 86 | 278.7 | 64.3 |
| 47 | 45.8 | 10.6 | 07 | 104.3 | 24.1 | 67 | 162.7 | 37.6 | 27 | 221.2 | 51.1 | 87 | 279.6 | 64.6 |
| 48 | 46.8 | 10.8 | 08 | 105.2 | 24.3 | 68 | 163.7 | 37.8 | 28 | 222.2 | 51.3 | 88 | 280.6 | 64.8 |
| 49 | 47.7 | 11.0 | 09 | 106.2 | 24.5 | 69 | 164.7 | 38.0 | 29 | 223.1 | 51.5 | 89 | 281.6 | 65.0 |
| 50 | 48.7 | 11.2 | 10 | 107.2 | 24.7 | 70 | 165.6 | 38.2 | 30 | 224.1 | 51.7 | 90 | 282.6 | 65.2 |
| 51 | 49.7 | 11.5 | 111 | 108.2 | 25.0 | 171 | 166.6 | 38.5 | 231 | 225.1 | 52.0 | 291 | 283.5 | 65.5 |
| 52 | 50.7 | 11.7 | 12 | 109.1 | 25.2 | 72 | 167.6 | 38.7 | 32 | 226.1 | 52.2 | 92 | 284.5 | 65.7 |
| 53 | 51.6 | 11.9 | 13 | 110.1 | 25.4 | 73 | 168.6 | 38.9 | 33 | 227.0 | 52.4 | 93 | 285.5 | 65.9 |
| 54 | 52.6 | 12.1 | 14 | 111.1 | 25.6 | 74 | 169.5 | 39.1 | 34 | 228.0 | 52.6 | 94 | 286.5 | 66.1 |
| 55 | 53.6 | 12.4 | 15 | 112.1 | 25.9 | 75 | 170.5 | 39.4 | 35 | 229.0 | 52.9 | 95 | 287.4 | 66.4 |
| 56 | 54.6 | 12.6 | 16 | 113.0 | 26.1 | 76 | 171.5 | 39.6 | 36 | 230.0 | 53.1 | 96 | 288.4 | 66.6 |
| 57 | 55.5 | 12.8 | 17 | 114.0 | 26.3 | 77 | 172.5 | 39.8 | 37 | 230.9 | 53.3 | 97 | 289.4 | 66.8 |
| 58 | 56.5 | 13.0 | 18 | 115.0 | 26.5 | 78 | 173.4 | 40.0 | 38 | 231.9 | 53.5 | 98 | 290.4 | 67.0 |
| 59 | 57.5 | 13.3 | 19 | 116.0 | 26.8 | 79 | 174.4 | 40.3 | 39 | 232.9 | 53.8 | 99 | 291.3 | 67.3 |
| 60 | 58.5 | 13.5 | 20 | 116.9 | 27.0 | 80 | 175.4 | 40.5 | 40 | 233.8 | 54.0 | 300 | 292.3 | 67.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 77° (103°, 257°, 283°).

TABLE 2. [Page 393

Difference of Latitude and Departure for 13° (167°, 193°, 347°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 293.3 | 67.7 | 361 | 351.8 | 81.2 | 421 | 410.2 | 94.7 | 481 | 468.7 | 108.2 | 541 | 527.2 | 121.7 |
| 02 | 294.3 | 67.9 | 62 | 352.7 | 81.4 | 22 | 411.2 | 94.9 | 82 | 469.7 | 108.4 | 42 | 528.1 | 121.9 |
| 03 | 295.2 | 68.1 | 63 | 353.7 | 81.6 | 23 | 412.2 | 95.1 | 83 | 470.6 | 108.6 | 43 | 529.1 | 122.1 |
| 04 | 296.2 | 68.4 | 64 | 354.7 | 81.9 | 24 | 413.1 | 95.3 | 84 | 471.6 | 108.8 | 44 | 530.1 | 122.3 |
| 05 | 297.2 | 68.6 | 65 | 355.6 | 82.1 | 25 | 414.1 | 95.6 | 85 | 472.6 | 109.0 | 45 | 531.1 | 122.5 |
| 06 | 298.2 | 68.8 | 66 | 356.6 | 82.3 | 26 | 415.1 | 95.8 | 86 | 473.6 | 109.3 | 46 | 532.0 | 122.8 |
| 07 | 299.1 | 69.0 | 67 | 357.6 | 82.5 | 27 | 416.1 | 96.0 | 87 | 474.5 | 109.5 | 47 | 533.0 | 123.0 |
| 08 | 300.1 | 69.3 | 68 | 358.6 | 82.8 | 28 | 417.0 | 96.2 | 88 | 475.5 | 109.7 | 48 | 534.0 | 123.2 |
| 09 | 301.1 | 69.5 | 69 | 359.5 | 83.0 | 29 | 418.0 | 96.5 | 89 | 476.5 | 109.9 | 49 | 535.0 | 123.4 |
| 10 | 302.1 | 69.7 | 70 | 360.5 | 83.2 | 30 | 419.0 | 96.7 | 90 | 477.5 | 110.1 | 50 | 535.9 | 123.7 |
| 311 | 303.0 | 69.9 | 371 | 361.5 | 83.4 | 431 | 420.0 | 96.9 | 491 | 478.4 | 110.4 | 551 | 536.9 | 123.9 |
| 12 | 304.0 | 70.2 | 72 | 362.5 | 83.7 | 32 | 420.9 | 97.1 | 92 | 479.4 | 110.6 | 52 | 537.9 | 124.1 |
| 13 | 305.0 | 70.4 | 73 | 363.4 | 83.9 | 33 | 421.9 | 97.4 | 93 | 480.4 | 110.9 | 53 | 538.9 | 124.4 |
| 14 | 306.0 | 70.6 | 74 | 364.4 | 84.1 | 34 | 422.9 | 97.6 | 94 | 481.4 | 111.1 | 54 | 539.8 | 124.6 |
| 15 | 306.9 | 70.8 | 75 | 365.4 | 84.3 | 35 | 423.9 | 97.8 | 95 | 482.3 | 111.3 | 55 | 540.8 | 124.9 |
| 16 | 307.9 | 71.1 | 76 | 366.4 | 84.6 | 36 | 424.8 | 98.0 | 96 | 483.3 | 111.5 | 56 | 541.8 | 125.1 |
| 17 | 308.9 | 71.3 | 77 | 367.3 | 84.8 | 37 | 425.8 | 98.3 | 97 | 484.3 | 111.8 | 57 | 542.8 | 125.3 |
| 18 | 309.9 | 71.5 | 78 | 368.3 | 85.0 | 38 | 426.8 | 98.5 | 98 | 485.3 | 112.0 | 58 | 543.7 | 125.5 |
| 19 | 310.8 | 71.7 | 79 | 369.3 | 85.2 | 39 | 427.8 | 98.7 | 99 | 486.2 | 112.2 | 59 | 544.7 | 125.8 |
| 20 | 311.8 | 72.0 | 80 | 370.3 | 85.5 | 40 | 428.7 | 98.9 | 500 | 487.2 | 112.4 | 60 | 545.7 | 126.0 |
| 321 | 312.8 | 72.2 | 381 | 371.2 | 85.7 | 441 | 429.7 | 99.2 | 501 | 488.2 | 112.6 | 561 | 546.7 | 126.2 |
| 22 | 313.8 | 72.4 | 82 | 372.2 | 85.9 | 42 | 430.7 | 99.4 | 02 | 489.2 | 112.9 | 62 | 547.6 | 126.4 |
| 23 | 314.7 | 72.6 | 83 | 373.2 | 86.1 | 43 | 431.6 | 99.6 | 03 | 490.1 | 113.1 | 63 | 548.6 | 126.7 |
| 24 | 315.7 | 72.9 | 84 | 374.2 | 86.4 | 44 | 432.6 | 99.8 | 04 | 491.1 | 113.3 | 64 | 549.6 | 126.9 |
| 25 | 316.7 | 73.1 | 85 | 375.1 | 86.6 | 45 | 433.6 | 100.1 | 05 | 492.1 | 113.5 | 65 | 550.6 | 127.1 |
| 26 | 317.6 | 73.3 | 86 | 376.1 | 86.8 | 46 | 434.6 | 100.3 | 06 | 493.1 | 113.8 | 66 | 551.5 | 127.3 |
| 27 | 318.6 | 73.5 | 87 | 377.1 | 87.0 | 47 | 435.5 | 100.5 | 07 | 494.0 | 114.0 | 67 | 552.5 | 127.6 |
| 28 | 319.6 | 73.8 | 88 | 378.1 | 87.3 | 48 | 436.5 | 100.7 | 08 | 495.0 | 114.2 | 68 | 553.5 | 127.8 |
| 29 | 320.6 | 74.0 | 89 | 379.0 | 87.5 | 49 | 437.5 | 101.0 | 09 | 496.0 | 114.5 | 69 | 554.5 | 128.0 |
| 30 | 321.5 | 74.2 | 90 | 380.0 | 87.7 | 50 | 438.5 | 101.2 | 10 | 496.9 | 114.7 | 70 | 555.4 | 128.3 |
| 331 | 322.5 | 74.4 | 391 | 381.0 | 87.9 | 451 | 439.4 | 101.4 | 511 | 497.9 | 114.9 | 571 | 556.4 | 128.5 |
| 32 | 323.5 | 74.7 | 92 | 382.0 | 88.2 | 52 | 440.4 | 101.6 | 12 | 498.9 | 115.1 | 72 | 557.4 | 128.7 |
| 33 | 324.5 | 74.9 | 93 | 382.9 | 88.4 | 53 | 441.4 | 101.9 | 13 | 499.9 | 115.4 | 73 | 558.4 | 128.9 |
| 34 | 325.4 | 75.1 | 94 | 383.9 | 88.6 | 54 | 442.4 | 102.1 | 14 | 500.8 | 115.6 | 74 | 559.3 | 129.2 |
| 35 | 326.4 | 75.3 | 95 | 384.9 | 88.8 | 55 | 443.3 | 102.3 | 15 | 501.8 | 115.8 | 75 | 560.3 | 129.4 |
| 36 | 327.4 | 75.6 | 96 | 385.9 | 89.1 | 56 | 444.3 | 102.5 | 16 | 502.8 | 116.0 | 76 | 561.3 | 129.6 |
| 37 | 328.4 | 75.8 | 97 | 386.8 | 89.3 | 57 | 445.3 | 102.8 | 17 | 503.8 | 116.3 | 77 | 562.3 | 129.8 |
| 38 | 329.3 | 76.0 | 98 | 387.8 | 89.5 | 58 | 446.3 | 103.0 | 18 | 504.7 | 116.5 | 78 | 563.2 | 130.0 |
| 39 | 330.3 | 76.2 | 99 | 388.8 | 89.7 | 59 | 447.2 | 103.2 | 19 | 505.7 | 116.7 | 79 | 564.2 | 130.2 |
| 40 | 331.3 | 76.5 | 400 | 389.8 | 90.0 | 60 | 448.2 | 103.4 | 20 | 506.7 | 116.9 | 80 | 565.2 | 130.4 |
| 341 | 332.3 | 76.7 | 401 | 390.7 | 90.2 | 461 | 449.2 | 103.7 | 521 | 507.7 | 117.2 | 581 | 566.2 | 130.7 |
| 42 | 333.2 | 76.9 | 02 | 391.7 | 90.4 | 62 | 450.2 | 103.9 | 22 | 508.6 | 117.5 | 82 | 567.1 | 131.0 |
| 43 | 334.2 | 77.1 | 03 | 392.7 | 90.6 | 63 | 451.1 | 104.1 | 23 | 509.6 | 117.7 | 83 | 568.1 | 131.2 |
| 44 | 335.2 | 77.4 | 04 | 393.6 | 90.8 | 64 | 452.1 | 104.3 | 24 | 510.6 | 117.9 | 84 | 569.1 | 131.4 |
| 45 | 336.2 | 77.6 | 05 | 394.6 | 91.1 | 65 | 453.1 | 104.6 | 25 | 511.6 | 118.1 | 85 | 570.1 | 131.6 |
| 46 | 337.1 | 77.8 | 06 | 395.6 | 91.3 | 66 | 454.1 | 104.8 | 26 | 512.5 | 118.3 | 86 | 571.0 | 131.8 |
| 47 | 338.1 | 78.0 | 07 | 396.6 | 91.5 | 67 | 455.0 | 105.0 | 27 | 513.5 | 118.5 | 87 | 572.0 | 132.0 |
| 48 | 339.1 | 78.3 | 08 | 397.5 | 91.7 | 68 | 456.0 | 105.2 | 28 | 514.5 | 118.7 | 88 | 573.0 | 132.3 |
| 49 | 340.1 | 78.5 | 09 | 398.5 | 92.0 | 69 | 457.0 | 105.5 | 29 | 515.5 | 119.0 | 89 | 573.9 | 132.5 |
| 50 | 341.0 | 78.7 | 10 | 399.5 | 92.2 | 70 | 458.0 | 105.7 | 30 | 516.4 | 119.2 | 90 | 574.9 | 132.8 |
| 351 | 342.0 | 78.9 | 411 | 400.5 | 92.4 | 471 | 458.9 | 105.9 | 531 | 517.4 | 119.4 | 591 | 575.9 | 133.0 |
| 52 | 343.0 | 79.2 | 12 | 401.4 | 92.6 | 72 | 459.9 | 106.1 | 32 | 518.4 | 119.6 | 92 | 576.9 | 133.2 |
| 53 | 344.0 | 79.4 | 13 | 402.4 | 92.9 | 73 | 460.9 | 106.4 | 33 | 519.4 | 119.9 | 93 | 577.8 | 133.4 |
| 54 | 344.9 | 79.6 | 14 | 403.4 | 93.1 | 74 | 461.9 | 106.6 | 34 | 520.3 | 120.1 | 94 | 578.8 | 133.6 |
| 55 | 345.9 | 79.8 | 15 | 404.4 | 93.3 | 75 | 462.8 | 106.8 | 35 | 521.3 | 120.3 | 95 | 579.8 | 133.8 |
| 56 | 346.9 | 80.1 | 16 | 405.3 | 93.5 | 76 | 463.8 | 107.0 | 36 | 522.3 | 120.5 | 96 | 580.8 | 134.0 |
| 57 | 347.9 | 80.3 | 17 | 406.3 | 93.8 | 77 | 464.8 | 107.3 | 37 | 523.3 | 120.8 | 97 | 581.7 | 134.3 |
| 58 | 348.8 | 80.5 | 18 | 407.3 | 94.0 | 78 | 465.8 | 107.5 | 38 | 524.2 | 121.0 | 98 | 582.7 | 134.5 |
| 59 | 349.8 | 80.7 | 19 | 408.3 | 94.2 | 79 | 466.7 | 107.7 | 39 | 525.2 | 121.2 | 99 | 583.7 | 134.8 |
| 60 | 350.8 | 81.0 | 20 | 409.2 | 94.4 | 80 | 467.7 | 107.9 | 40 | 526.2 | 121.5 | 600 | 584.6 | 135.0 |
| Dist. | Dep. | Lat. | Dist | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

77° (103°, 257°, 283°).

# TABLE 2.

Difference of Latitude and Departure for 14° (166°, 194°, 346°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.2 | 61 | 59.2 | 14.8 | 121 | 117.4 | 29.3 | 181 | 175.6 | 43.8 | 241 | 233.8 | 58.3 |
| 2 | 1.9 | 0.5 | 62 | 60.2 | 15.0 | 22 | 118.4 | 29.5 | 82 | 176.6 | 44.0 | 42 | 234.8 | 58.5 |
| 3 | 2.9 | 0.7 | 63 | 61.1 | 15.2 | 23 | 119.3 | 29.8 | 83 | 177.6 | 44.3 | 43 | 235.8 | 58.8 |
| 4 | 3.9 | 1.0 | 64 | 62.1 | 15.5 | 24 | 120.3 | 30.0 | 84 | 178.5 | 44.5 | 44 | 236.8 | 59.0 |
| 5 | 4.9 | 1.2 | 65 | 63.1 | 15.7 | 25 | 121.3 | 30.2 | 85 | 179.5 | 44.8 | 45 | 237.7 | 59.3 |
| 6 | 5.8 | 1.5 | 66 | 64.0 | 16.0 | 26 | 122.3 | 30.5 | 86 | 180.5 | 45.0 | 46 | 238.7 | 59.5 |
| 7 | 6.8 | 1.7 | 67 | 65.0 | 16.2 | 27 | 123.2 | 30.7 | 87 | 181.4 | 45.2 | 47 | 239.7 | 59.8 |
| 8 | 7.8 | 1.9 | 68 | 66.0 | 16.5 | 28 | 124.2 | 31.0 | 88 | 182.4 | 45.5 | 48 | 240.6 | 60.0 |
| 9 | 8.7 | 2.2 | 69 | 67.0 | 16.7 | 29 | 125.2 | 31.2 | 89 | 183.4 | 45.7 | 49 | 241.6 | 60.2 |
| 10 | 9.7 | 2.4 | 70 | 67.9 | 16.9 | 30 | 126.1 | 31.4 | 90 | 184.4 | 46.0 | 50 | 242.6 | 60.5 |
| 11 | 10.7 | 2.7 | 71 | 68.9 | 17.2 | 131 | 127.1 | 31.7 | 191 | 185.3 | 46.2 | 251 | 243.5 | 60.7 |
| 12 | 11.6 | 2.9 | 72 | 69.9 | 17.4 | 32 | 128.1 | 31.9 | 92 | 186.3 | 46.4 | 52 | 244.5 | 61.0 |
| 13 | 12.6 | 3.1 | 73 | 70.8 | 17.7 | 33 | 129.0 | 32.2 | 93 | 187.3 | 46.7 | 53 | 245.5 | 61.2 |
| 14 | 13.6 | 3.4 | 74 | 71.8 | 17.9 | 34 | 130.0 | 32.4 | 94 | 188.2 | 46.9 | 54 | 246.5 | 61.4 |
| 15 | 14.6 | 3.6 | 75 | 72.8 | 18.1 | 35 | 131.0 | 32.7 | 95 | 189.2 | 47.2 | 55 | 247.4 | 61.7 |
| 16 | 15.5 | 3.9 | 76 | 73.7 | 18.4 | 36 | 132.0 | 32.9 | 96 | 190.2 | 47.4 | 56 | 248.4 | 61.9 |
| 17 | 16.5 | 4.1 | 77 | 74.7 | 18.6 | 37 | 132.9 | 33.1 | 97 | 191.1 | 47.7 | 57 | 249.4 | 62.2 |
| 18 | 17.5 | 4.4 | 78 | 75.7 | 18.9 | 38 | 133.9 | 33.4 | 98 | 192.1 | 47.9 | 58 | 250.3 | 62.4 |
| 19 | 18.4 | 4.6 | 79 | 76.7 | 19.1 | 39 | 134.9 | 33.6 | 99 | 193.1 | 48.1 | 59 | 251.3 | 62.7 |
| 20 | 19.4 | 4.8 | 80 | 77.6 | 19.4 | 40 | 135.8 | 33.9 | 200 | 194.1 | 48.4 | 60 | 252.3 | 62.9 |
| 21 | 20.4 | 5.1 | 81 | 78.6 | 19.6 | 141 | 136.8 | 34.1 | 201 | 195.0 | 48.6 | 261 | 253.2 | 63.1 |
| 22 | 21.3 | 5.3 | 82 | 79.6 | 19.8 | 42 | 137.8 | 34.4 | 02 | 196.0 | 48.9 | 62 | 254.2 | 63.4 |
| 23 | 22.3 | 5.6 | 83 | 80.5 | 20.1 | 43 | 138.8 | 34.6 | 03 | 197.0 | 49.1 | 63 | 255.2 | 63.6 |
| 24 | 23.3 | 5.8 | 84 | 81.5 | 20.3 | 44 | 139.7 | 34.8 | 04 | 197.9 | 49.4 | 64 | 256.2 | 63.9 |
| 25 | 24.3 | 6.0 | 85 | 82.5 | 20.6 | 45 | 140.7 | 35.1 | 05 | 198.9 | 49.6 | 65 | 257.1 | 64.1 |
| 26 | 25.2 | 6.3 | 86 | 83.4 | 20.8 | 46 | 141.7 | 35.3 | 06 | 199.9 | 49.8 | 66 | 258.1 | 64.4 |
| 27 | 26.2 | 6.5 | 87 | 84.4 | 21.0 | 47 | 142.6 | 35.6 | 07 | 200.9 | 50.1 | 67 | 259.1 | 64.6 |
| 28 | 27.2 | 6.8 | 88 | 85.4 | 21.3 | 48 | 143.6 | 35.8 | 08 | 201.8 | 50.3 | 68 | 260.0 | 64.8 |
| 29 | 28.1 | 7.0 | 89 | 86.4 | 21.5 | 49 | 144.6 | 36.0 | 09 | 202.8 | 50.6 | 69 | 261.0 | 65.1 |
| 30 | 29.1 | 7.3 | 90 | 87.3 | 21.8 | 50 | 145.5 | 36.3 | 10 | 203.8 | 50.8 | 70 | 262.0 | 65.3 |
| 31 | 30.1 | 7.5 | 91 | 88.3 | 22.0 | 151 | 146.5 | 36.5 | 211 | 204.7 | 51.0 | 271 | 263.0 | 65.6 |
| 32 | 31.0 | 7.7 | 92 | 89.3 | 22.3 | 52 | 147.5 | 36.8 | 12 | 205.7 | 51.3 | 72 | 263.9 | 65.8 |
| 33 | 32.0 | 8.0 | 93 | 90.2 | 22.5 | 53 | 148.5 | 37.0 | 13 | 206.7 | 51.5 | 73 | 264.9 | 66.0 |
| 34 | 33.0 | 8.2 | 94 | 91.2 | 22.7 | 54 | 149.4 | 37.3 | 14 | 207.6 | 51.8 | 74 | 265.9 | 66.3 |
| 35 | 34.0 | 8.5 | 95 | 92.2 | 23.0 | 55 | 150.4 | 37.5 | 15 | 208.6 | 52.0 | 75 | 266.8 | 66.5 |
| 36 | 34.9 | 8.7 | 96 | 93.1 | 23.2 | 56 | 151.4 | 37.7 | 16 | 209.6 | 52.3 | 76 | 267.8 | 66.8 |
| 37 | 35.9 | 9.0 | 97 | 94.1 | 23.5 | 57 | 152.3 | 38.0 | 17 | 210.6 | 52.5 | 77 | 268.8 | 67.0 |
| 38 | 36.9 | 9.2 | 98 | 95.1 | 23.7 | 58 | 153.3 | 38.2 | 18 | 211.5 | 52.7 | 78 | 269.7 | 67.3 |
| 39 | 37.8 | 9.4 | 99 | 96.1 | 24.0 | 59 | 154.3 | 38.5 | 19 | 212.5 | 53.0 | 79 | 270.7 | 67.5 |
| 40 | 38.8 | 9.7 | 100 | 97.0 | 24.2 | 60 | 155.2 | 38.7 | 20 | 213.5 | 53.2 | 80 | 271.7 | 67.7 |
| 41 | 39.8 | 9.9 | 101 | 98.0 | 24.4 | 161 | 156.2 | 38.9 | 221 | 214.4 | 53.5 | 281 | 272.7 | 68.0 |
| 42 | 40.8 | 10.2 | 02 | 99.0 | 24.7 | 62 | 157.2 | 39.2 | 22 | 215.4 | 53.7 | 82 | 273.6 | 68.2 |
| 43 | 41.7 | 10.4 | 03 | 99.9 | 24.9 | 63 | 158.2 | 39.4 | 23 | 216.4 | 53.9 | 83 | 274.6 | 68.5 |
| 44 | 42.7 | 10.6 | 04 | 100.9 | 25.2 | 64 | 159.1 | 39.7 | 24 | 217.3 | 54.2 | 84 | 275.6 | 68.7 |
| 45 | 43.7 | 10.9 | 05 | 101.9 | 25.4 | 65 | 160.1 | 39.9 | 25 | 218.3 | 54.4 | 85 | 276.5 | 68.9 |
| 46 | 44.6 | 11.1 | 06 | 102.9 | 25.6 | 66 | 161.1 | 40.2 | 26 | 219.3 | 54.7 | 86 | 277.5 | 69.2 |
| 47 | 45.6 | 11.4 | 07 | 103.8 | 25.9 | 67 | 162.0 | 40.4 | 27 | 220.3 | 54.9 | 87 | 278.5 | 69.4 |
| 48 | 46.6 | 11.6 | 08 | 104.8 | 26.1 | 68 | 163.0 | 40.6 | 28 | 221.2 | 55.2 | 88 | 279.4 | 69.7 |
| 49 | 47.5 | 11.9 | 09 | 105.8 | 26.4 | 69 | 164.0 | 40.9 | 29 | 222.2 | 55.4 | 89 | 280.4 | 69.9 |
| 50 | 48.5 | 12.1 | 10 | 106.7 | 26.6 | 70 | 165.0 | 41.1 | 30 | 223.2 | 55.6 | 90 | 281.4 | 70.2 |
| 51 | 49.5 | 12.3 | 111 | 107.7 | 26.9 | 171 | 165.9 | 41.4 | 231 | 224.1 | 55.9 | 291 | 282.4 | 70.4 |
| 52 | 50.5 | 12.6 | 12 | 108.7 | 27.1 | 72 | 166.9 | 41.6 | 32 | 225.1 | 56.1 | 92 | 283.3 | 70.6 |
| 53 | 51.4 | 12.8 | 13 | 109.6 | 27.3 | 73 | 167.9 | 41.9 | 33 | 226.1 | 56.4 | 93 | 284.3 | 70.9 |
| 54 | 52.4 | 13.1 | 14 | 110.6 | 27.6 | 74 | 168.8 | 42.1 | 34 | 227.0 | 56.6 | 94 | 285.3 | 71.1 |
| 55 | 53.4 | 13.3 | 15 | 111.6 | 27.8 | 75 | 169.8 | 42.3 | 35 | 228.0 | 56.9 | 95 | 286.2 | 71.4 |
| 56 | 54.3 | 13.5 | 16 | 112.6 | 28.1 | 76 | 170.8 | 42.6 | 36 | 229.0 | 57.1 | 96 | 287.2 | 71.6 |
| 57 | 55.3 | 13.8 | 17 | 113.5 | 28.3 | 77 | 171.7 | 42.8 | 37 | 230.0 | 57.3 | 97 | 288.2 | 71.9 |
| 58 | 56.3 | 14.0 | 18 | 114.5 | 28.5 | 78 | 172.7 | 43.1 | 38 | 230.9 | 57.6 | 98 | 289.1 | 72.1 |
| 59 | 57.2 | 14.3 | 19 | 115.5 | 28.8 | 79 | 173.7 | 43.3 | 39 | 231.9 | 57.8 | 99 | 290.1 | 72.3 |
| 60 | 58.2 | 14.5 | 20 | 116.4 | 29.0 | 80 | 174.7 | 43.5 | 40 | 232.9 | 58.1 | 300 | 291.1 | 72.6 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

76° (104°, 256°, 284°).

## TABLE 2. [Page 395

Difference of Latitude and Departure for 14° (166°, 194°, 346°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 292.0 | 72.8 | 361 | 350.2 | 87.3 | 421 | 408.5 | 101.8 | 481 | 466.7 | 116.3 | 541 | 525.0 | 130.9 |
| 02 | 293.0 | 73.0 | 62 | 351.2 | 87.6 | 22 | 409.4 | 102.1 | 82 | 467.7 | 116.6 | 42 | 525.9 | 131.2 |
| 03 | 294.0 | 73.3 | 63 | 352.2 | 87.8 | 23 | 410.4 | 102.3 | 83 | 468.6 | 116.8 | 43 | 526.9 | 131.4 |
| 04 | 294.9 | 73.5 | 64 | 353.2 | 88.0 | 24 | 411.4 | 102.6 | 84 | 469.6 | 117.1 | 44 | 527.9 | 131.6 |
| 05 | 295.9 | 73.8 | 65 | 354.1 | 88.3 | 25 | 412.3 | 102.8 | 85 | 470.6 | 117.3 | 45 | 528.8 | 131.9 |
| 06 | 296.9 | 74.0 | 66 | 355.1 | 88.5 | 26 | 413.3 | 103.0 | 86 | 471.5 | 117.6 | 46 | 529.8 | 132.1 |
| 07 | 297.8 | 74.2 | 67 | 356.1 | 88.8 | 27 | 414.3 | 103.3 | 87 | 472.5 | 117.8 | 47 | 530.8 | 132.3 |
| 08 | 298.8 | 74.5 | 68 | 357.0 | 89.0 | 28 | 415.3 | 103.5 | 88 | 473.5 | 118.0 | 48 | 531.7 | 132.6 |
| 09 | 299.8 | 74.7 | 69 | 358.0 | 89.2 | 29 | 416.2 | 103.8 | 89 | 474.5 | 118.3 | 49 | 532.7 | 132.8 |
| 10 | 300.8 | 75.0 | 70 | 359.0 | 89.5 | 30 | 417.2 | 104.0 | 90 | 475.4 | 118.5 | 50 | 533.7 | 133.0 |
| 311 | 301.7 | 75.2 | 371 | 359.9 | 89.7 | 431 | 418.2 | 104.2 | 491 | 476.4 | 118.8 | 551 | 534.6 | 133.3 |
| 12 | 302.7 | 75.5 | 72 | 360.9 | 90.0 | 32 | 419.1 | 104.5 | 92 | 477.4 | 119.0 | 52 | 535.6 | 133.6 |
| 13 | 303.7 | 75.7 | 73 | 361.9 | 90.2 | 33 | 420.1 | 104.7 | 93 | 478.3 | 119.2 | 53 | 536.6 | 133.8 |
| 14 | 304.6 | 75.9 | 74 | 362.9 | 90.5 | 34 | 421.1 | 105.0 | 94 | 479.3 | 119.5 | 54 | 537.5 | 134.0 |
| 15 | 305.6 | 76.2 | 75 | 363.8 | 90.7 | 35 | 422.0 | 105.2 | 95 | 480.3 | 119.7 | 55 | 538.5 | 134.3 |
| 16 | 306.6 | 76.4 | 76 | 364.8 | 90.9 | 36 | 423.0 | 105.5 | 96 | 481.3 | 120.0 | 56 | 539.5 | 134.5 |
| 17 | 307.6 | 76.7 | 77 | 365.8 | 91.2 | 37 | 424.0 | 105.7 | 97 | 482.2 | 120.2 | 57 | 540.5 | 134.8 |
| 18 | 308.5 | 76.9 | 78 | 366.7 | 91.4 | 38 | 425.0 | 105.9 | 98 | 483.2 | 120.4 | 58 | 541.4 | 135.0 |
| 19 | 309.5 | 77.2 | 79 | 367.7 | 91.7 | 39 | 425.9 | 106.2 | 99 | 484.2 | 120.7 | 59 | 542.4 | 135.2 |
| 20 | 310.5 | 77.4 | 80 | 368.7 | 91.9 | 40 | 426.9 | 106.4 | 500 | 485.1 | 121.0 | 60 | 543.4 | 135.5 |
| 321 | 311.4 | 77.6 | 381 | 369.6 | 92.2 | 441 | 427.9 | 106.7 | 501 | 486.1 | 121.2 | 561 | 544.3 | 135.7 |
| 22 | 312.4 | 77.9 | 82 | 370.6 | 92.4 | 42 | 428.8 | 106.9 | 02 | 487.1 | 121.4 | 62 | 545.3 | 135.9 |
| 23 | 313.4 | 78.1 | 83 | 371.6 | 92.6 | 43 | 429.8 | 107.1 | 03 | 488.0 | 121.7 | 63 | 546.3 | 136.2 |
| 24 | 314.3 | 78.4 | 84 | 372.6 | 92.9 | 44 | 430.8 | 107.4 | 04 | 489.0 | 122.0 | 64 | 547.2 | 136.5 |
| 25 | 315.3 | 78.6 | 85 | 373.5 | 93.1 | 45 | 431.7 | 107.6 | 05 | 490.0 | 122.1 | 65 | 548.2 | 136.6 |
| 26 | 316.3 | 78.8 | 86 | 374.5 | 93.4 | 46 | 432.7 | 107.9 | 06 | 491.0 | 122.4 | 66 | 549.2 | 136.9 |
| 27 | 317.3 | 79.1 | 87 | 375.5 | 93.6 | 47 | 433.7 | 108.1 | 07 | 491.9 | 122.6 | 67 | 550.1 | 137.1 |
| 28 | 318.2 | 79.3 | 88 | 376.4 | 93.8 | 48 | 434.7 | 108.4 | 08 | 492.9 | 122.9 | 68 | 551.1 | 137.4 |
| 29 | 319.2 | 79.6 | 89 | 377.4 | 94.1 | 49 | 435.6 | 108.6 | 09 | 493.9 | 123.1 | 69 | 552.1 | 137.6 |
| 30 | 320.2 | 79.8 | 90 | 378.4 | 94.3 | 50 | 436.6 | 108.8 | 10 | 494.9 | 123.4 | 70 | 553.1 | 137.9 |
| 331 | 321.1 | 80.1 | 391 | 379.4 | 94.6 | 451 | 437.6 | 109.1 | 511 | 495.8 | 123.6 | 571 | 554.0 | 138.1 |
| 32 | 322.1 | 80.3 | 92 | 380.3 | 94.8 | 52 | 438.5 | 109.3 | 12 | 496.8 | 123.8 | 72 | 555.0 | 138.3 |
| 33 | 323.1 | 80.5 | 93 | 381.3 | 95.1 | 53 | 439.5 | 109.6 | 13 | 497.8 | 124.1 | 73 | 556.0 | 138.6 |
| 34 | 324.0 | 80.8 | 94 | 382.3 | 95.3 | 54 | 440.5 | 109.8 | 14 | 498.7 | 124.3 | 74 | 557.0 | 138.8 |
| 35 | 325.0 | 81.0 | 95 | 383.2 | 95.5 | 55 | 441.5 | 110.1 | 15 | 499.7 | 124.6 | 75 | 557.9 | 139.1 |
| 36 | 326.0 | 81.3 | 96 | 384.2 | 95.8 | 56 | 442.4 | 110.3 | 16 | 500.7 | 124.8 | 76 | 558.9 | 139.3 |
| 37 | 327.0 | 81.5 | 97 | 385.2 | 96.0 | 57 | 443.4 | 110.5 | 17 | 501.7 | 125.0 | 77 | 559.9 | 139.5 |
| 38 | 327.9 | 81.7 | 98 | 386.1 | 96.3 | 58 | 444.4 | 110.8 | 18 | 502.6 | 125.3 | 78 | 560.9 | 139.8 |
| 39 | 328.9 | 82.0 | 99 | 387.1 | 96.5 | 59 | 445.3 | 111.0 | 19 | 503.6 | 125.6 | 79 | 561.8 | 140.0 |
| 40 | 329.9 | 82.2 | 400 | 388.1 | 96.7 | 60 | 446.3 | 111.3 | 20 | 504.6 | 125.8 | 80 | 562.8 | 140.3 |
| 341 | 330.8 | 82.5 | 401 | 389.1 | 97.0 | 461 | 447.3 | 111.5 | 521 | 505.5 | 126.0 | 581 | 563.8 | 140.5 |
| 42 | 331.8 | 82.7 | 02 | 390.0 | 97.2 | 62 | 448.2 | 111.7 | 22 | 506.5 | 126.2 | 82 | 564.7 | 140.8 |
| 43 | 332.8 | 83.0 | 03 | 391.0 | 97.5 | 63 | 449.2 | 112.0 | 23 | 507.5 | 126.5 | 83 | 565.7 | 141.0 |
| 44 | 333.7 | 83.2 | 04 | 392.0 | 97.7 | 64 | 450.2 | 112.2 | 24 | 508.4 | 126.8 | 84 | 566.7 | 141.3 |
| 45 | 334.7 | 83.4 | 05 | 392.9 | 98.0 | 65 | 451.2 | 112.5 | 25 | 509.4 | 127.0 | 85 | 567.6 | 141.5 |
| 46 | 335.7 | 83.7 | 06 | 393.9 | 98.2 | 66 | 452.1 | 112.7 | 26 | 510.4 | 127.2 | 86 | 568.6 | 141.8 |
| 47 | 336.7 | 83.9 | 07 | 394.9 | 98.4 | 67 | 453.1 | 113.0 | 27 | 511.4 | 127.5 | 87 | 569.6 | 142.0 |
| 48 | 337.6 | 84.2 | 08 | 395.8 | 98.7 | 68 | 454.1 | 113.2 | 28 | 512.3 | 127.8 | 88 | 570.6 | 142.3 |
| 49 | 338.6 | 84.4 | 09 | 396.8 | 98.9 | 69 | 455.0 | 113.4 | 29 | 513.3 | 128.0 | 89 | 571.5 | 142.5 |
| 50 | 339.6 | 84.7 | 10 | 397.8 | 99.2 | 70 | 456.0 | 113.7 | 30 | 514.3 | 128.2 | 90 | 572.5 | 142.8 |
| 351 | 340.5 | 84.9 | 411 | 398.8 | 99.4 | 471 | 457.0 | 113.9 | 531 | 515.3 | 128.5 | 591 | 573.5 | 143.0 |
| 52 | 341.5 | 85.1 | 12 | 399.7 | 99.7 | 72 | 457.9 | 114.2 | 32 | 516.2 | 128.8 | 92 | 574.4 | 143.3 |
| 53 | 342.5 | 85.4 | 13 | 400.7 | 99.9 | 73 | 458.9 | 114.4 | 33 | 517.2 | 129.0 | 93 | 575.4 | 143.5 |
| 54 | 343.5 | 85.6 | 14 | 401.7 | 100.1 | 74 | 459.9 | 114.6 | 34 | 518.2 | 129.2 | 94 | 576.4 | 143.8 |
| 55 | 344.4 | 85.9 | 15 | 402.6 | 100.4 | 75 | 460.9 | 114.9 | 35 | 519.1 | 129.4 | 95 | 577.3 | 144.0 |
| 56 | 345.4 | 86.1 | 16 | 403.6 | 100.6 | 76 | 461.8 | 115.1 | 36 | 520.1 | 129.7 | 96 | 578.3 | 144.2 |
| 57 | 346.4 | 86.3 | 17 | 404.6 | 100.9 | 77 | 462.8 | 115.4 | 37 | 521.1 | 129.9 | 97 | 579.3 | 144.5 |
| 58 | 347.3 | 86.6 | 18 | 405.5 | 101.1 | 78 | 463.8 | 115.6 | 38 | 522.1 | 130.2 | 98 | 580.3 | 144.7 |
| 59 | 348.3 | 86.8 | 19 | 406.5 | 101.3 | 79 | 464.7 | 115.9 | 39 | 523.0 | 130.4 | 99 | 581.2 | 144.9 |
| 60 | 349.3 | 87.1 | 20 | 407.5 | 101.6 | 80 | 465.7 | 116.1 | 40 | 524.0 | 130.6 | 600 | 582.2 | 145.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

76° (104°, 256°, 284°).

Difference of Latitude and Departure for 15° (165°, 195°, 345°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.3 | 61 | 58.9 | 15.8 | 121 | 116.9 | 31.3 | 181 | 174.8 | 46.8 | 241 | 232.8 | 62.4 |
| 2 | 1.9 | 0.5 | 62 | 59.9 | 16.0 | 22 | 117.8 | 31.6 | 82 | 175.8 | 47.1 | 42 | 233.8 | 62.6 |
| 3 | 2.9 | 0.8 | 63 | 60.9 | 16.3 | 23 | 118.8 | 31.8 | 83 | 176.8 | 47.4 | 43 | 234.7 | 62.9 |
| 4 | 3.9 | 1.0 | 64 | 61.8 | 16.6 | 24 | 119.8 | 32.1 | 84 | 177.7 | 47.6 | 44 | 235.7 | 63.2 |
| 5 | 4.8 | 1.3 | 65 | 62.8 | 16.8 | 25 | 120.7 | 32.4 | 85 | 178.7 | 47.9 | 45 | 236.7 | 63.4 |
| 6 | 5.8 | 1.6 | 66 | 63.8 | 17.1 | 26 | 121.7 | 32.6 | 86 | 179.7 | 48.1 | 46 | 237.6 | 63.7 |
| 7 | 6.8 | 1.8 | 67 | 64.7 | 17.3 | 27 | 122.7 | 32.9 | 87 | 180.6 | 48.4 | 47 | 238.6 | 63.9 |
| 8 | 7.7 | 2.1 | 68 | 65.7 | 17.6 | 28 | 123.6 | 33.1 | 88 | 181.6 | 48.7 | 48 | 239.5 | 64.2 |
| 9 | 8.7 | 2.3 | 69 | 66.6 | 17.9 | 29 | 124.6 | 33.4 | 89 | 182.6 | 48.9 | 49 | 240.5 | 64.4 |
| 10 | 9.7 | 2.6 | 70 | 67.6 | 18.1 | 30 | 125.6 | 33.6 | 90 | 183.5 | 49.2 | 50 | 241.5 | 64.7 |
| 11 | 10.6 | 2.8 | 71 | 68.6 | 18.4 | 131 | 126.5 | 33.9 | 191 | 184.5 | 49.4 | 251 | 242.4 | 65.0 |
| 12 | 11.6 | 3.1 | 72 | 69.5 | 18.6 | 32 | 127.5 | 34.2 | 92 | 185.5 | 49.7 | 52 | 243.4 | 65.2 |
| 13 | 12.6 | 3.4 | 73 | 70.5 | 18.9 | 33 | 128.5 | 34.4 | 93 | 186.4 | 50.0 | 53 | 244.4 | 65.5 |
| 14 | 13.5 | 3.6 | 74 | 71.5 | 19.2 | 34 | 129.4 | 34.7 | 94 | 187.4 | 50.2 | 54 | 245.3 | 65.7 |
| 15 | 14.5 | 3.9 | 75 | 72.4 | 19.4 | 35 | 130.4 | 34.9 | 95 | 188.4 | 50.5 | 55 | 246.3 | 66.0 |
| 16 | 15.5 | 4.1 | 76 | 73.4 | 19.7 | 36 | 131.4 | 35.2 | 96 | 189.3 | 50.7 | 56 | 247.3 | 66.3 |
| 17 | 16.4 | 4.4 | 77 | 74.4 | 19.9 | 37 | 132.3 | 35.5 | 97 | 190.3 | 51.0 | 57 | 248.2 | 66.5 |
| 18 | 17.4 | 4.7 | 78 | 75.3 | 20.2 | 38 | 133.3 | 35.7 | 98 | 191.3 | 51.2 | 58 | 249.2 | 66.8 |
| 19 | 18.4 | 4.9 | 79 | 76.3 | 20.4 | 39 | 134.3 | 36.0 | 99 | 192.2 | 51.5 | 59 | 250.2 | 67.0 |
| 20 | 19.3 | 5.2 | 80 | 77.3 | 20.7 | 40 | 135.2 | 36.2 | 200 | 193.2 | 51.8 | 60 | 251.1 | 67.3 |
| 21 | 20.3 | 5.4 | 81 | 78.2 | 21.0 | 141 | 136.2 | 36.5 | 201 | 194.2 | 52.0 | 261 | 252.1 | 67.6 |
| 22 | 21.3 | 5.7 | 82 | 79.2 | 21.2 | 42 | 137.2 | 36.8 | 02 | 195.1 | 52.3 | 62 | 253.1 | 67.8 |
| 23 | 22.2 | 6.0 | 83 | 80.2 | 21.5 | 43 | 138.1 | 37.0 | 03 | 196.1 | 52.5 | 63 | 254.0 | 68.1 |
| 24 | 23.2 | 6.2 | 84 | 81.1 | 21.7 | 44 | 139.1 | 37.3 | 04 | 197.0 | 52.8 | 64 | 255.0 | 68.3 |
| 25 | 24.1 | 6.5 | 85 | 82.1 | 22.0 | 45 | 140.1 | 37.5 | 05 | 198.0 | 53.1 | 65 | 256.0 | 68.6 |
| 26 | 25.1 | 6.7 | 86 | 83.1 | 22.3 | 46 | 141.0 | 37.8 | 06 | 199.0 | 53.3 | 66 | 256.9 | 68.8 |
| 27 | 26.1 | 7.0 | 87 | 84.0 | 22.5 | 47 | 142.0 | 38.0 | 07 | 199.9 | 53.6 | 67 | 257.9 | 69.1 |
| 28 | 27.0 | 7.2 | 88 | 85.0 | 22.8 | 48 | 143.0 | 38.3 | 08 | 200.9 | 53.8 | 68 | 258.9 | 69.4 |
| 29 | 28.0 | 7.5 | 89 | 86.0 | 23.0 | 49 | 143.9 | 38.6 | 09 | 201.9 | 54.1 | 69 | 259.8 | 69.6 |
| 30 | 29.0 | 7.8 | 90 | 86.9 | 23.3 | 50 | 144.9 | 38.8 | 10 | 202.8 | 54.4 | 70 | 260.8 | 69.9 |
| 31 | 29.9 | 8.0 | 91 | 87.9 | 23.6 | 151 | 145.9 | 39.1 | 211 | 203.8 | 54.6 | 271 | 261.8 | 70.1 |
| 32 | 30.9 | 8.3 | 92 | 88.9 | 23.8 | 52 | 146.8 | 39.3 | 12 | 204.8 | 54.9 | 72 | 262.7 | 70.4 |
| 33 | 31.9 | 8.5 | 93 | 89.8 | 24.1 | 53 | 147.8 | 39.6 | 13 | 205.7 | 55.1 | 73 | 263.7 | 70.7 |
| 34 | 32.8 | 8.8 | 94 | 90.8 | 24.3 | 54 | 148.8 | 39.9 | 14 | 206.7 | 55.4 | 74 | 264.7 | 70.9 |
| 35 | 33.8 | 9.1 | 95 | 91.8 | 24.6 | 55 | 149.7 | 40.1 | 15 | 207.7 | 55.6 | 75 | 265.6 | 71.2 |
| 36 | 34.8 | 9.3 | 96 | 92.7 | 24.8 | 56 | 150.7 | 40.4 | 16 | 208.6 | 55.9 | 76 | 266.6 | 71.4 |
| 37 | 35.7 | 9.6 | 97 | 93.7 | 25.1 | 57 | 151.7 | 40.6 | 17 | 209.6 | 56.2 | 77 | 267.6 | 71.7 |
| 38 | 36.7 | 9.8 | 98 | 94.7 | 25.4 | 58 | 152.6 | 40.9 | 18 | 210.6 | 56.4 | 78 | 268.5 | 72.0 |
| 39 | 37.7 | 10.1 | 99 | 95.6 | 25.6 | 59 | 153.6 | 41.2 | 19 | 211.5 | 56.7 | 79 | 269.5 | 72.2 |
| 40 | 38.6 | 10.4 | 100 | 96.6 | 25.9 | 60 | 154.5 | 41.4 | 20 | 212.5 | 56.9 | 80 | 270.5 | 72.5 |
| 41 | 39.6 | 10.6 | 101 | 97.6 | 26.1 | 161 | 155.5 | 41.7 | 221 | 213.5 | 57.2 | 281 | 271.4 | 72.7 |
| 42 | 40.6 | 10.9 | 02 | 98.5 | 26.4 | 62 | 156.5 | 41.9 | 22 | 214.4 | 57.5 | 82 | 272.4 | 73.0 |
| 43 | 41.5 | 11.1 | 03 | 99.5 | 26.7 | 63 | 157.4 | 42.2 | 23 | 215.4 | 57.7 | 83 | 273.4 | 73.2 |
| 44 | 42.5 | 11.4 | 04 | 100.5 | 26.9 | 64 | 158.4 | 42.4 | 24 | 216.4 | 58.0 | 84 | 274.3 | 73.5 |
| 45 | 43.5 | 11.6 | 05 | 101.4 | 27.2 | 65 | 159.4 | 42.7 | 25 | 217.3 | 58.2 | 85 | 275.3 | 73.8 |
| 46 | 44.4 | 11.9 | 06 | 102.4 | 27.4 | 66 | 160.3 | 43.0 | 26 | 218.3 | 58.5 | 86 | 276.3 | 74.0 |
| 47 | 45.4 | 12.2 | 07 | 103.4 | 27.7 | 67 | 161.3 | 43.2 | 27 | 219.3 | 58.8 | 87 | 277.2 | 74.3 |
| 48 | 46.4 | 12.4 | 08 | 104.3 | 28.0 | 68 | 162.3 | 43.5 | 28 | 220.2 | 59.0 | 88 | 278.2 | 74.5 |
| 49 | 47.3 | 12.7 | 09 | 105.3 | 28.2 | 69 | 163.2 | 43.7 | 29 | 221.2 | 59.3 | 89 | 279.2 | 74.8 |
| 50 | 48.3 | 12.9 | 10 | 106.3 | 28.5 | 70 | 164.2 | 44.0 | 30 | 222.2 | 59.5 | 90 | 280.1 | 75.1 |
| 51 | 49.3 | 13.2 | 111 | 107.2 | 28.7 | 171 | 165.2 | 44.3 | 231 | 223.1 | 59.8 | 291 | 281.1 | 75.3 |
| 52 | 50.2 | 13.5 | 12 | 108.2 | 29.0 | 72 | 166.1 | 44.5 | 32 | 224.1 | 60.0 | 92 | 282.1 | 75.6 |
| 53 | 51.2 | 13.7 | 13 | 109.1 | 29.2 | 73 | 167.1 | 44.8 | 33 | 225.1 | 60.3 | 93 | 283.0 | 75.8 |
| 54 | 52.2 | 14.0 | 14 | 110.1 | 29.5 | 74 | 168.1 | 45.0 | 34 | 226.0 | 60.6 | 94 | 284.0 | 76.1 |
| 55 | 53.1 | 14.2 | 15 | 111.1 | 29.8 | 75 | 169.0 | 45.3 | 35 | 227.0 | 60.8 | 95 | 284.9 | 76.4 |
| 56 | 54.1 | 14.5 | 16 | 112.0 | 30.0 | 76 | 170.0 | 45.6 | 36 | 228.0 | 61.1 | 96 | 285.9 | 76.6 |
| 57 | 55.1 | 14.8 | 17 | 113.0 | 30.3 | 77 | 171.0 | 45.8 | 37 | 228.9 | 61.3 | 97 | 286.9 | 76.9 |
| 58 | 56.0 | 15.0 | 18 | 114.0 | 30.5 | 78 | 171.9 | 46.1 | 38 | 229.9 | 61.6 | 98 | 287.8 | 77.1 |
| 59 | 57.0 | 15.3 | 19 | 114.9 | 30.8 | 79 | 172.9 | 46.3 | 39 | 230.9 | 61.9 | 99 | 288.8 | 77.4 |
| 60 | 58.0 | 15.5 | 20 | 115.9 | 31.1 | 80 | 173.9 | 46.6 | 40 | 231.8 | 62.1 | 300 | 289.8 | 77.6 |

| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

75° (105°, 255°, 285°).

TABLE 2. [Page 397

Difference of Latitude and Departure for 15° (165°, 195°, 345°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 290.7 | 77.9 | 361 | 348.7 | 93.4 | 421 | 406.6 | 109.0 | 481 | 464.6 | 124.5 | 541 | 522.6 | 140.0 |
| 02 | 291.7 | 78.2 | 62 | 349.6 | 93.7 | 22 | 407.6 | 109.2 | 82 | 465.6 | 124.8 | 42 | 523.5 | 140.3 |
| 03 | 292.7 | 78.4 | 63 | 350.6 | 94.0 | 23 | 408.6 | 109.5 | 83 | 466.5 | 125.0 | 43 | 524.5 | 140.5 |
| 04 | 293.6 | 78.7 | 64 | 351.6 | 94.2 | 24 | 409.5 | 109.7 | 84 | 467.5 | 125.3 | 44 | 525.5 | 140.8 |
| 05 | 294.6 | 78.9 | 65 | 352.5 | 94.5 | 25 | 410.5 | 110.0 | 85 | 468.5 | 125.6 | 45 | 526.4 | 141.1 |
| 06 | 295.6 | 79.2 | 66 | 353.5 | 94.7 | 26 | 411.5 | 110.3 | 86 | 469.4 | 125.8 | 46 | 527.4 | 141.4 |
| 07 | 296.5 | 79.5 | 67 | 354.5 | 95.0 | 27 | 412.4 | 110.5 | 87 | 470.4 | 126.1 | 47 | 528.4 | 141.6 |
| 08 | 297.5 | 79.7 | 68 | 355.4 | 95.3 | 28 | 413.4 | 110.8 | 88 | 471.4 | 126.4 | 48 | 529.3 | 141.9 |
| 09 | 298.4 | 80.0 | 69 | 356.4 | 95.5 | 29 | 414.4 | 111.0 | 89 | 472.3 | 126.6 | 49 | 530.3 | 142.1 |
| 10 | 299.4 | 80.2 | 70 | 357.4 | 95.8 | 30 | 415.3 | 111.3 | 90 | 473.3 | 126.9 | 50 | 531.3 | 142.4 |
| 311 | 300.4 | 80.5 | 371 | 358.3 | 96.0 | 431 | 416.3 | 111.6 | 491 | 474.3 | 127.1 | 551 | 532.2 | 142.6 |
| 12 | 301.3 | 80.8 | 72 | 359.3 | 96.3 | 32 | 417.3 | 111.8 | 92 | 475.2 | 127.4 | 52 | 533.2 | 142.9 |
| 13 | 302.3 | 81.0 | 73 | 360.3 | 96.5 | 33 | 418.2 | 112.1 | 93 | 476.2 | 127.6 | 53 | 534.2 | 143.1 |
| 14 | 303.3 | 81.3 | 74 | 361.2 | 96.8 | 34 | 419.2 | 112.3 | 94 | 477.2 | 127.9 | 54 | 535.1 | 143.4 |
| 15 | 304.2 | 81.5 | 75 | 362.2 | 97.1 | 35 | 420.2 | 112.6 | 95 | 478.1 | 128.1 | 55 | 536.1 | 143.7 |
| 16 | 305.2 | 81.8 | 76 | 363.2 | 97.3 | 36 | 421.1 | 112.9 | 96 | 479.1 | 128.4 | 56 | 537.1 | 143.9 |
| 17 | 306.2 | 82.1 | 77 | 364.1 | 97.6 | 37 | 422.1 | 113.1 | 97 | 480.1 | 128.6 | 57 | 538.0 | 144.2 |
| 18 | 307.1 | 82.3 | 78 | 365.1 | 97.8 | 38 | 423.1 | 113.4 | 98 | 481.0 | 128.9 | 58 | 539.0 | 144.4 |
| 19 | 308.1 | 82.6 | 79 | 366.1 | 98.1 | 39 | 424.0 | 113.6 | 99 | 482.0 | 129.1 | 59 | 540.0 | 144.7 |
| 20 | 309.1 | 82.8 | 80 | 367.0 | 98.4 | 40 | 425.0 | 113.9 | 500 | 483.0 | 129.4 | 60 | 540.9 | 144.9 |
| 321 | 310.0 | 83.1 | 381 | 368.0 | 98.6 | 441 | 426.0 | 114.1 | 501 | 483.9 | 129.7 | 561 | 541.9 | 145.2 |
| 22 | 311.0 | 83.3 | 82 | 369.0 | 98.9 | 42 | 426.9 | 114.4 | 02 | 484.9 | 129.9 | 62 | 542.9 | 145.4 |
| 23 | 312.0 | 83.6 | 83 | 369.9 | 99.1 | 43 | 427.9 | 114.7 | 03 | 485.9 | 130.2 | 63 | 543.8 | 145.7 |
| 24 | 312.9 | 83.9 | 84 | 370.9 | 99.4 | 44 | 428.8 | 114.9 | 04 | 486.8 | 130.4 | 64 | 544.8 | 146.0 |
| 25 | 313.9 | 84.1 | 85 | 371.9 | 99.6 | 45 | 429.8 | 115.2 | 05 | 487.8 | 130.7 | 65 | 545.8 | 146.2 |
| 26 | 314.9 | 84.4 | 86 | 372.8 | 99.9 | 46 | 430.8 | 115.4 | 06 | 488.8 | 131.0 | 66 | 546.7 | 146.5 |
| 27 | 315.8 | 84.6 | 87 | 373.8 | 100.2 | 47 | 431.7 | 115.7 | 07 | 489.7 | 131.2 | 67 | 547.7 | 146.7 |
| 28 | 316.8 | 84.9 | 88 | 374.8 | 100.4 | 48 | 432.7 | 116.0 | 08 | 490.7 | 131.5 | 68 | 548.7 | 147.0 |
| 29 | 317.8 | 85.1 | 89 | 375.7 | 100.7 | 49 | 433.7 | 116.2 | 09 | 491.7 | 131.7 | 69 | 549.6 | 147.2 |
| 30 | 318.7 | 85.4 | 90 | 376.7 | 100.9 | 50 | 434.6 | 116.5 | 10 | 492.6 | 132.0 | 70 | 550.6 | 147.5 |
| 331 | 319.7 | 85.7 | 391 | 377.7 | 101.2 | 451 | 435.6 | 116.7 | 511 | 493.6 | 132.3 | 571 | 551.6 | 147.8 |
| 32 | 320.7 | 85.9 | 92 | 378.6 | 101.5 | 52 | 436.6 | 117.0 | 12 | 494.5 | 132.5 | 72 | 552.5 | 148.0 |
| 33 | 321.6 | 86.2 | 93 | 379.6 | 101.7 | 53 | 437.5 | 117.3 | 13 | 495.5 | 132.8 | 73 | 553.5 | 148.3 |
| 34 | 322.6 | 86.5 | 94 | 380.6 | 102.0 | 54 | 438.5 | 117.5 | 14 | 496.5 | 133.0 | 74 | 554.4 | 148.5 |
| 35 | 323.6 | 86.7 | 95 | 381.5 | 102.2 | 55 | 439.5 | 117.8 | 15 | 497.4 | 133.3 | 75 | 555.4 | 148.8 |
| 36 | 324.5 | 87.0 | 96 | 382.5 | 102.5 | 56 | 440.4 | 118.0 | 16 | 498.4 | 133.5 | 76 | 556.4 | 149.0 |
| 37 | 325.5 | 87.2 | 97 | 383.4 | 102.8 | 57 | 441.4 | 118.3 | 17 | 499.4 | 133.8 | 77 | 557.3 | 149.3 |
| 38 | 326.5 | 87.5 | 98 | 384.4 | 103.0 | 58 | 442.4 | 118.5 | 18 | 500.3 | 134.0 | 78 | 558.3 | 149.5 |
| 39 | 327.4 | 87.7 | 99 | 385.4 | 103.3 | 59 | 443.3 | 118.8 | 19 | 501.3 | 134.3 | 79 | 559.3 | 149.8 |
| 40 | 328.4 | 88.0 | 400 | 386.3 | 103.5 | 60 | 444.3 | 119.1 | 20 | 502.3 | 134.6 | 80 | 560.2 | 150.1 |
| 341 | 329.4 | 88.3 | 401 | 387.3 | 103.8 | 461 | 445.3 | 119.3 | 521 | 503.2 | 134.8 | 581 | 561.2 | 150.3 |
| 42 | 330.3 | 88.5 | 02 | 388.3 | 104.1 | 62 | 446.2 | 119.6 | 22 | 504.2 | 135.1 | 82 | 562.2 | 150.6 |
| 43 | 331.3 | 88.8 | 03 | 389.2 | 104.3 | 63 | 447.2 | 119.8 | 23 | 505.2 | 135.3 | 83 | 563.1 | 150.8 |
| 44 | 332.3 | 89.0 | 04 | 390.2 | 104.6 | 64 | 448.2 | 120.1 | 24 | 506.1 | 135.6 | 84 | 564.1 | 151.1 |
| 45 | 333.2 | 89.3 | 05 | 391.2 | 104.8 | 65 | 449.1 | 120.4 | 25 | 507.1 | 135.9 | 85 | 565.1 | 151.4 |
| 46 | 334.2 | 89.6 | 06 | 392.1 | 105.1 | 66 | 450.1 | 120.6 | 26 | 508.1 | 136.1 | 86 | 566.0 | 151.6 |
| 47 | 335.2 | 89.8 | 07 | 393.1 | 105.3 | 67 | 451.1 | 120.9 | 27 | 509.0 | 136.4 | 87 | 567.0 | 151.9 |
| 48 | 336.1 | 90.1 | 08 | 394.1 | 105.6 | 68 | 452.0 | 121.1 | 28 | 510.0 | 136.6 | 88 | 568.0 | 152.2 |
| 49 | 337.1 | 90.3 | 09 | 395.0 | 105.9 | 69 | 453.0 | 121.4 | 29 | 511.0 | 136.9 | 89 | 568.9 | 152.4 |
| 50 | 338.1 | 90.6 | 10 | 396.0 | 106.1 | 70 | 454.0 | 121.7 | 30 | 511.9 | 137.2 | 90 | 569.9 | 152.7 |
| 351 | 339.0 | 90.9 | 411 | 397.0 | 106.4 | 471 | 454.9 | 121.9 | 531 | 512.9 | 137.4 | 591 | 570.9 | 153.0 |
| 52 | 340.0 | 91.1 | 12 | 397.9 | 106.6 | 72 | 455.9 | 122.2 | 32 | 513.9 | 137.7 | 92 | 571.8 | 153.2 |
| 53 | 340.9 | 91.4 | 13 | 398.9 | 106.9 | 73 | 456.9 | 122.4 | 33 | 514.8 | 137.9 | 93 | 572.8 | 153.5 |
| 54 | 341.9 | 91.6 | 14 | 399.9 | 107.2 | 74 | 457.8 | 122.7 | 34 | 515.8 | 138.2 | 94 | 573.8 | 153.7 |
| 55 | 342.9 | 91.9 | 15 | 400.8 | 107.4 | 75 | 458.8 | 122.9 | 35 | 516.8 | 138.4 | 95 | 574.7 | 154.0 |
| 56 | 343.8 | 92.1 | 16 | 401.8 | 107.7 | 76 | 459.8 | 123.2 | 36 | 517.7 | 138.7 | 96 | 575.7 | 154.2 |
| 57 | 344.8 | 92.4 | 17 | 402.8 | 107.9 | 77 | 460.7 | 123.5 | 37 | 518.7 | 139.0 | 97 | 576.7 | 154.5 |
| 58 | 345.8 | 92.7 | 18 | 403.7 | 108.2 | 78 | 461.7 | 123.7 | 38 | 519.7 | 139.2 | 98 | 577.6 | 154.8 |
| 59 | 346.7 | 92.9 | 19 | 404.7 | 108.5 | 79 | 462.7 | 124.0 | 39 | 520.6 | 139.5 | 99 | 578.6 | 155.0 |
| 60 | 347.7 | 93.2 | 20 | 405.7 | 108.7 | 80 | 463.6 | 124.2 | 40 | 521.6 | 139.7 | 600 | 579.5 | 155.3 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

75° (105°, 255°, 285°).

# TABLE 2.

Difference of Latitude and Departure for 16° (164°, 196°, 344°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.3 | 61 | 58.6 | 16.8 | 121 | 116.3 | 33.4 | 181 | 174.0 | 49.9 | 241 | 231.7 | 66.4 |
| 2 | 1.9 | 0.6 | 62 | 59.6 | 17.1 | 22 | 117.3 | 33.6 | 82 | 174.9 | 50.2 | 42 | 232.6 | 66.7 |
| 3 | 2.9 | 0.8 | 63 | 60.6 | 17.4 | 23 | 118.2 | 33.9 | 83 | 175.9 | 50.4 | 43 | 233.6 | 67.0 |
| 4 | 3.8 | 1.1 | 64 | 61.5 | 17.6 | 24 | 119.2 | 34.2 | 84 | 176.9 | 50.7 | 44 | 234.5 | 67.3 |
| 5 | 4.8 | 1.4 | 65 | 62.5 | 17.9 | 25 | 120.2 | 34.5 | 85 | 177.8 | 51.0 | 45 | 235.5 | 67.5 |
| 6 | 5.8 | 1.7 | 66 | 63.4 | 18.2 | 26 | 121.1 | 34.7 | 86 | 178.8 | 51.3 | 46 | 236.5 | 67.8 |
| 7 | 6.7 | 1.9 | 67 | 64.4 | 18.5 | 27 | 122.1 | 35.0 | 87 | 179.8 | 51.5 | 47 | 237.4 | 68.1 |
| 8 | 7.7 | 2.2 | 68 | 65.4 | 18.7 | 28 | 123.0 | 35.3 | 88 | 180.7 | 51.8 | 48 | 238.4 | 68.4 |
| 9 | 8.7 | 2.5 | 69 | 66.3 | 19.0 | 29 | 124.0 | 35.6 | 89 | 181.7 | 52.1 | 49 | 239.4 | 68.6 |
| 10 | 9.6 | 2.8 | 70 | 67.3 | 19.3 | 30 | 125.0 | 35.8 | 90 | 182.6 | 52.4 | 50 | 240.3 | 68.9 |
| 11 | 10.6 | 3.0 | 71 | 68.2 | 19.6 | 131 | 125.9 | 36.1 | 191 | 183.6 | 52.6 | 251 | 241.3 | 69.2 |
| 12 | 11.5 | 3.3 | 72 | 69.2 | 19.8 | 32 | 126.9 | 36.4 | 92 | 184.6 | 52.9 | 52 | 242.2 | 69.5 |
| 13 | 12.5 | 3.6 | 73 | 70.2 | 20.1 | 33 | 127.8 | 36.7 | 93 | 185.5 | 53.2 | 53 | 243.2 | 69.7 |
| 14 | 13.5 | 3.9 | 74 | 71.1 | 20.4 | 34 | 128.8 | 36.9 | 94 | 186.5 | 53.5 | 54 | 244.2 | 70.0 |
| 15 | 14.4 | 4.1 | 75 | 72.1 | 20.7 | 35 | 129.8 | 37.2 | 95 | 187.4 | 53.7 | 55 | 245.1 | 70.3 |
| 16 | 15.4 | 4.4 | 76 | 73.1 | 20.9 | 36 | 130.7 | 37.5 | 96 | 188.4 | 54.0 | 56 | 246.1 | 70.6 |
| 17 | 16.3 | 4.7 | 77 | 74.0 | 21.2 | 37 | 131.7 | 37.8 | 97 | 189.4 | 54.3 | 57 | 247.0 | 70.8 |
| 18 | 17.3 | 5.0 | 78 | 75.0 | 21.5 | 38 | 132.7 | 38.0 | 98 | 190.3 | 54.6 | 58 | 248.0 | 71.1 |
| 19 | 18.3 | 5.2 | 79 | 75.9 | 21.8 | 39 | 133.6 | 38.3 | 99 | 191.3 | 54.9 | 59 | 249.0 | 71.4 |
| 20 | 19.2 | 5.5 | 80 | 76.9 | 22.1 | 40 | 134.6 | 38.6 | 200 | 192.3 | 55.1 | 60 | 249.9 | 71.7 |
| 21 | 20.2 | 5.8 | 81 | 77.9 | 22.3 | 141 | 135.5 | 38.9 | 201 | 193.2 | 55.4 | 261 | 250.9 | 71.9 |
| 22 | 21.1 | 6.1 | 82 | 78.8 | 22.6 | 42 | 136.5 | 39.1 | 02 | 194.2 | 55.7 | 62 | 251.9 | 72.2 |
| 23 | 22.1 | 6.3 | 83 | 79.8 | 22.9 | 43 | 137.5 | 39.4 | 03 | 195.1 | 56.0 | 63 | 252.8 | 72.5 |
| 24 | 23.1 | 6.6 | 84 | 80.7 | 23.2 | 44 | 138.4 | 39.7 | 04 | 196.1 | 56.2 | 64 | 253.8 | 72.8 |
| 25 | 24.0 | 6.9 | 85 | 81.7 | 23.4 | 45 | 139.4 | 40.0 | 05 | 197.1 | 56.5 | 65 | 254.7 | 73.0 |
| 26 | 25.0 | 7.2 | 86 | 82.7 | 23.7 | 46 | 140.3 | 40.2 | 06 | 198.0 | 56.8 | 66 | 255.7 | 73.3 |
| 27 | 26.0 | 7.4 | 87 | 83.6 | 24.0 | 47 | 141.3 | 40.5 | 07 | 199.0 | 57.1 | 67 | 256.7 | 73.6 |
| 28 | 26.9 | 7.7 | 88 | 84.6 | 24.3 | 48 | 142.3 | 40.8 | 08 | 199.9 | 57.3 | 68 | 257.6 | 73.9 |
| 29 | 27.9 | 8.0 | 89 | 85.6 | 24.5 | 49 | 143.2 | 41.1 | 09 | 200.9 | 57.6 | 69 | 258.6 | 74.1 |
| 30 | 28.8 | 8.3 | 90 | 86.5 | 24.8 | 50 | 144.2 | 41.3 | 10 | 201.9 | 57.9 | 70 | 259.5 | 74.4 |
| 31 | 29.8 | 8.5 | 91 | 87.5 | 25.1 | 151 | 145.2 | 41.6 | 211 | 202.8 | 58.2 | 271 | 260.5 | 74.7 |
| 32 | 30.8 | 8.8 | 92 | 88.4 | 25.4 | 52 | 146.1 | 41.9 | 12 | 203.8 | 58.4 | 72 | 261.5 | 75.0 |
| 33 | 31.7 | 9.1 | 93 | 89.4 | 25.6 | 53 | 147.1 | 42.2 | 13 | 204.7 | 58.7 | 73 | 262.4 | 75.2 |
| 34 | 32.7 | 9.4 | 94 | 90.4 | 25.9 | 54 | 148.0 | 42.4 | 14 | 205.7 | 59.0 | 74 | 263.4 | 75.5 |
| 35 | 33.6 | 9.6 | 95 | 91.3 | 26.2 | 55 | 149.0 | 42.7 | 15 | 206.7 | 59.3 | 75 | 264.3 | 75.8 |
| 36 | 34.6 | 9.9 | 96 | 92.3 | 26.5 | 56 | 150.0 | 43.0 | 16 | 207.6 | 59.5 | 76 | 265.3 | 76.1 |
| 37 | 35.6 | 10.2 | 97 | 93.2 | 26.7 | 57 | 150.9 | 43.3 | 17 | 208.6 | 59.8 | 77 | 266.3 | 76.4 |
| 38 | 36.5 | 10.5 | 98 | 94.2 | 27.0 | 58 | 151.9 | 43.6 | 18 | 209.6 | 60.1 | 78 | 267.2 | 76.6 |
| 39 | 37.5 | 10.7 | 99 | 95.2 | 27.3 | 59 | 152.8 | 43.8 | 19 | 210.5 | 60.4 | 79 | 268.2 | 76.9 |
| 40 | 38.5 | 11.0 | 100 | 96.1 | 27.6 | 60 | 153.8 | 44.1 | 20 | 211.5 | 60.6 | 80 | 269.2 | 77.2 |
| 41 | 39.4 | 11.3 | 101 | 97.1 | 27.8 | 161 | 154.8 | 44.4 | 221 | 212.4 | 60.9 | 281 | 270.1 | 77.5 |
| 42 | 40.4 | 11.6 | 02 | 98.0 | 28.1 | 62 | 155.7 | 44.7 | 22 | 213.4 | 61.2 | 82 | 271.1 | 77.7 |
| 43 | 41.3 | 11.9 | 03 | 99.0 | 28.4 | 63 | 156.7 | 44.9 | 23 | 214.4 | 61.5 | 83 | 272.0 | 78.0 |
| 44 | 42.3 | 12.1 | 04 | 100.0 | 28.7 | 64 | 157.6 | 45.2 | 24 | 215.3 | 61.7 | 84 | 273.0 | 78.3 |
| 45 | 43.3 | 12.4 | 05 | 100.9 | 28.9 | 65 | 158.6 | 45.5 | 25 | 216.3 | 62.0 | 85 | 274.0 | 78.6 |
| 46 | 44.2 | 12.7 | 06 | 101.9 | 29.2 | 66 | 159.6 | 45.8 | 26 | 217.2 | 62.3 | 86 | 274.9 | 78.8 |
| 47 | 45.2 | 13.0 | 07 | 102.9 | 29.5 | 67 | 160.5 | 46.0 | 27 | 218.2 | 62.6 | 87 | 275.9 | 79.1 |
| 48 | 46.1 | 13.2 | 08 | 103.8 | 29.8 | 68 | 161.5 | 46.3 | 28 | 219.2 | 62.8 | 88 | 276.8 | 79.4 |
| 49 | 47.1 | 13.5 | 09 | 104.8 | 30.0 | 69 | 162.5 | 46.6 | 29 | 220.1 | 63.1 | 89 | 277.8 | 79.7 |
| 50 | 48.1 | 13.8 | 10 | 105.7 | 30.3 | 70 | 163.4 | 46.9 | 30 | 221.1 | 63.4 | 90 | 278.8 | 79.9 |
| 51 | 49.0 | 14.1 | 111 | 106.7 | 30.6 | 171 | 164.4 | 47.1 | 231 | 222.1 | 63.7 | 291 | 279.7 | 80.2 |
| 52 | 50.0 | 14.3 | 12 | 107.7 | 30.9 | 72 | 165.3 | 47.4 | 32 | 223.0 | 63.9 | 92 | 280.7 | 80.5 |
| 53 | 50.9 | 14.6 | 13 | 108.6 | 31.1 | 73 | 166.3 | 47.7 | 33 | 224.0 | 64.2 | 93 | 281.6 | 80.8 |
| 54 | 51.9 | 14.9 | 14 | 109.6 | 31.4 | 74 | 167.3 | 48.0 | 34 | 224.9 | 64.5 | 94 | 282.6 | 81.0 |
| 55 | 52.9 | 15.2 | 15 | 110.5 | 31.7 | 75 | 168.2 | 48.2 | 35 | 225.9 | 64.8 | 95 | 283.6 | 81.3 |
| 56 | 53.8 | 15.4 | 16 | 111.5 | 32.0 | 76 | 169.2 | 48.5 | 36 | 226.9 | 65.1 | 96 | 284.5 | 81.6 |
| 57 | 54.8 | 15.7 | 17 | 112.5 | 32.2 | 77 | 170.1 | 48.8 | 37 | 227.8 | 65.3 | 97 | 285.5 | 81.9 |
| 58 | 55.8 | 16.0 | 18 | 113.4 | 32.5 | 78 | 171.1 | 49.1 | 38 | 228.8 | 65.6 | 98 | 286.5 | 82.1 |
| 59 | 56.7 | 16.3 | 19 | 114.4 | 32.8 | 79 | 172.1 | 49.3 | 39 | 229.7 | 65.9 | 99 | 287.4 | 82.4 |
| 60 | 57.7 | 16.5 | 20 | 115.4 | 33.1 | 80 | 173.0 | 49.6 | 40 | 230.7 | 66.2 | 300 | 288.4 | 82.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

74° (106°, 254°, 286°).

TABLE 2. [Page 399

## Difference of Latitude and Departure for 16° (164°, 196°, 344°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 289.3 | 82.9 | 361 | 347.0 | 99.5 | 421 | 404.7 | 116.0 | 481 | 462.4 | 132.5 | 541 | 520.1 | 149.1 |
| 02 | 290.3 | 83.2 | 62 | 348.0 | 99.7 | 22 | 405.6 | 116.3 | 82 | 463.3 | 132.8 | 42 | 521.0 | 149.4 |
| 03 | 291.2 | 83.5 | 63 | 348.9 | 100.0 | 23 | 406.6 | 116.6 | 83 | 464.3 | 133.1 | 43 | 522.0 | 149.7 |
| 04 | 292.2 | 83.8 | 64 | 349.9 | 100.3 | 24 | 407.6 | 116.8 | 84 | 465.2 | 133.4 | 44 | 523.0 | 150.0 |
| 05 | 293.2 | 84.0 | 65 | 350.8 | 100.6 | 25 | 408.5 | 117.1 | 85 | 466.2 | 133.6 | 45 | 523.9 | 150.2 |
| 06 | 294.1 | 84.3 | 66 | 351.8 | 100.8 | 26 | 409.5 | 117.4 | 86 | 467.2 | 133.9 | 46 | 524.9 | 150.4 |
| 07 | 295.1 | 84.6 | 67 | 352.8 | 101.1 | 27 | 410.4 | 117.7 | 87 | 468.1 | 134.2 | 47 | 525.9 | 150.7 |
| 08 | 296.0 | 84.9 | 68 | 353.7 | 101.4 | 28 | 411.4 | 117.9 | 88 | 469.1 | 134.5 | 48 | 526.8 | 151.0 |
| 09 | 297.0 | 85.1 | 69 | 354.7 | 101.7 | ·29 | 412.4 | 118.2 | 89 | 470.1 | 134.8 | 49 | 527.8 | 151.3 |
| 10 | 298.0 | 85.4 | 70 | 355.6 | 101.9 | 30 | 413.3 | 118.5 | 90 | 471.0 | 135.0 | 50 | 528.7 | 151.6 |
| 311 | 298.9 | 85.7 | 371 | 356.6 | 102.2 | 431 | 414.3 | 118.8 | 491 | 472.0 | 135.3 | 551 | 529.7 | 151.9 |
| 12 | 299.9 | 86.0 | 72 | 357.6 | 102.5 | 32 | 415.2 | 119.0 | 92 | 472.9 | 135.6 | 52 | 530.6 | 152.2 |
| 13 | 300.9 | 86.2 | 73 | 358.5 | 102.8 | 33 | 416.2 | 119.3 | 93 | 473.9 | 135.9 | 53 | 531.6 | 152.5 |
| 14 | 301.8 | 86.5 | 74 | 359.5 | 103.1 | 34 | 417.2 | 119.6 | 94 | 474.9 | 136.2 | 54 | 532.6 | 152.8 |
| 15 | 302.8 | 86.8 | 75 | 360.4 | 103.3 | 35 | 418.1 | 119.9 | 95 | 475.8 | 136.4 | 55 | 533.5 | 153.0 |
| 16 | 303.7 | 87.1 | 76 | 361.4 | 103.6 | 36 | 419.1 | 120.1 | 96 | 476.8 | 136.7 | 56 | 534.5 | 153.2 |
| 17 | 304.7 | 87.3 | 77 | 362.4 | 103.9 | 37 | 420.0 | 120.4 | 97 | 477.7 | 137.0 | 57 | 535.4 | 153.5 |
| 18 | 305.7 | 87.6 | 78 | 363.3 | 104.2 | 38 | 421.0 | 120.7 | 98 | 478.7 | 137.3 | 58 | 536.4 | 153.8 |
| 19 | 306.6 | 87.9 | 79 | 364.3 | 104.4 | 39 | 422.0 | 121.0 | 99 | 479.7 | 137.5 | 59 | 537.4 | 154.1 |
| 20 | 307.6 | 88.2 | 80 | 365.3 | 104.7 | 40 | 422.9 | 121.2 | 500 | 480.6 | 137.8 | 60 | 538.3 | 154.4 |
| 321 | 308.5 | 88.4 | 381 | 366.2 | 105.0 | 441 | 423.9 | 121.5 | 501 | 481.6 | 138.1 | 561 | 539.3 | 154.7 |
| 22 | 309.5 | 88.7 | 82 | 367.2 | 105.3 | 42 | 424.9 | 121.8 | 02 | 482.6 | 138.3 | 62 | 540.3 | 154.9 |
| 23 | 310.5 | 89.0 | 83 | 368.1 | 105.5 | 43 | 425.8 | 122.1 | 03 | 483.5 | 138.6 | 63 | 541.2 | 155.2 |
| 24 | 311.4 | 89.3 | 84 | 369.1 | 105.8 | 44 | 426.8 | 122.3 | 04 | 484.5 | 138.9 | 64 | 542.2 | 155.4 |
| 25 | 312.4 | 89.5 | 85 | 370.1 | 106.1 | 45 | 427.7 | 122.6 | 05 | 485.4 | 139.2 | 65 | 543.1 | 155.7 |
| 26 | 313.3 | 89.8 | 86 | 371.0 | 106.4 | 46 | 428.7 | 122.9 | 06 | 486.4 | 139.4 | 66 | 544.1 | 156.0 |
| 27 | 314.3 | 90.1 | 87 | 372.0 | 106.6 | 47 | 429.7 | 123.2 | 07 | 487.3 | 139.7 | 67 | 545.1 | 156.3 |
| 28 | 315.3 | 90.4 | 88 | 372.9 | 106.9 | 48 | 430.6 | 123.4 | 08 | 488.3 | 140.0 | 68 | 546.0 | 156.6 |
| 29 | 316.2 | 90.6 | 89 | 373.9 | 107.2 | 49 | 431.6 | 123.7 | 09 | 489.3 | 140.3 | 69 | 547.0 | 156.9 |
| 30 | 317.2 | 90.9 | 90 | 374.9 | 107.5 | 50 | 432.6 | 124.0 | 10 | 490.2 | 140.6 | 70 | 547.9 | 157.1 |
| 331 | 318.2 | 91.2 | 391 | 375.8 | 107.7 | 451 | 433.5 | 124.3 | 511 | 491.2 | 140.8 | 571 | 548.9 | 157.3 |
| 32 | 319.1 | 91.5 | 92 | 376.8 | 108.0 | 52 | 434.5 | 124.6 | 12 | 492.1 | 141.1 | 72 | 549.8 | 157.6 |
| 33 | 320.1 | 91.8 | 93 | 377.8 | 108.3 | 53 | 435.4 | 124.8 | 13 | 493.1 | 141.4 | 73 | 550.8 | 157.9 |
| 34 | 321.0 | 92.0 | 94 | 378.7 | 108.6 | 54 | 436.4 | 125.1 | 14 | 494.1 | 141.7 | 74 | 551.8 | 158.2 |
| 35 | 322.0 | 92.3 | 95 | 379.7 | 108.8 | 55 | 437.4 | 125.4 | 15 | 495.0 | 141.9 | 75 | 552.7 | 158.4 |
| 36 | 323.0 | 92.6 | 96 | 380.6 | 109.1 | 56 | 438.3 | 125.7 | 16 | 496.0 | 142.2 | 76 | 553.7 | 158.7 |
| 37 | 323.9 | 92.9 | 97 | 381.6 | 109.4 | 57 | 439.3 | 125.9 | 17 | 496.9 | 142.5 | 77 | 554.6 | 159.0 |
| 38 | 324.9 | 93.1 | 98 | 382.6 | 109.7 | 58 | 440.2 | 126.2 | 18 | 497.9 | 142.8 | 78 | 555.6 | 159.3 |
| 39 | 325.8 | 93.4 | 99 | 383.5 | 109.9 | 59 | 441.2 | 126.5 | 19 | 498.9 | 143.0 | 79 | 556.5 | 159.5 |
| 40 | 326.8 | 93.7 | 400 | 384.5 | 110.2 | 60 | 442.2 | 126.8 | 20 | 499.8 | 143.3 | 80 | 557.5 | 159.8 |
| 341 | 327.8 | 94.0 | 401 | 385.4 | 110.5 | 461 | 443.1 | 127.0 | 521 | 500.8 | 143.6 | 581 | 558.4 | 160.1 |
| 42 | 328.7 | 94.2 | 02 | 386.4 | 110.8 | 62 | 444.1 | 127.3 | 22 | 501.7 | 143.9 | 82 | 559.4 | 160.4 |
| 43 | 329.7 | 94.5 | 03 | 387.4 | 111.0 | 63 | 445.0 | 127.6 | 23 | 502.7 | 144.1 | 83 | 560.4 | 160.6 |
| 44 | 330.7 | 94.8 | 04 | 388.3 | 111.3 | 64 | 446.0 | 127.9 | 24 | 503.7 | 144.4 | 84 | 561.3 | 161.0 |
| 45 | 331.6 | 95.1 | 05 | 389.3 | 111.6 | 65 | 447.0 | 128.1 | 25 | 504.6 | 144.7 | 85 | 562.3 | 161.3 |
| 46 | 332.6 | 95.3 | 06 | 390.2 | 111.9 | 66 | 447.9 | 128.4 | 26 | 505.6 | 145.0 | 86 | 563.2 | 161.6 |
| 47 | 333.5 | 95.6 | 07 | 391.2 | 112.1 | 67 | 448.9 | 128.7 | 27 | 506.6 | 145.3 | 87 | 564.2 | 161.8 |
| 48 | 334.5 | 95.9 | 08 | 392.2 | 112.4 | 68 | 449.8 | 129.0 | 28 | 507.5 | 145.6 | 88 | 565.2 | 162.1 |
| 49 | 335.5 | 96.2 | 09 | 393.1 | 112.7 | 69 | 450.8 | 129.2 | 29 | 508.5 | 145.8 | 89 | 566.1 | 162.4 |
| 50 | 336.4 | 96.4 | 10 | 394.1 | 113.0 | 70 | 451.8 | 129.5 | 30 | 509.4 | 146.1 | 90 | 567.1 | 162.7 |
| 351 | 337.4 | 96.7 | 411 | 395.1 | 113.3 | 471 | 452.7 | 129.8 | 531 | 510.4 | 146.4 | 591 | 568.1 | 162.9 |
| 52 | 338.3 | 97.0 | 12· | 396.0 | 113.5 | 72 | 453.7 | 130.1 | 32 | 511.4 | 146.7 | 92 | 569.0 | 163.2 |
| 53 | 339.3 | 97.3 | 13 | 397.0 | 113.8 | 73 | 454.7 | 130.3 | 33 | 512.3 | 146.9 | 93 | 570.0 | 163.5 |
| 54 | 340.3 | 97.5 | 14 | 397.9 | 114.1 | 74 | 455.6 | 130.6 | 34 | 513.3 | 147.2 | 94 | 571.0 | 163.8 |
| 55 | 341.2 | 97.8 | 15 | 398.9 | 114.4 | 75 | 456.6 | 130.9 | 35 | 514.3 | 147.5 | 95 | 571.9 | 164.0 |
| 56 | 342.2 | 98.1 | 16 | 399.9 | 114.6 | 76 | 457.5 | 131.2 | 36 | 515.2 | 147.8 | 96 | 572.9 | 164.3 |
| 57 | 343.1 | 98.4 | 17 | 400.8 | 114.9 | 77 | 458.5 | 131.4 | 37 | 516.2 | 148.0 | 97 | 573.9 | 164.6 |
| 58 | 344.1 | 98.6 | 18 | 401.8 | 115.2 | 78 | 459.5 | 131.7 | 38 | 517.2 | 148.2 | 98 | 574.8 | 164.9 |
| 59 | 345.1 | 98.9 | 19 | 402.7 | 115.5 | 79 | 460.4 | 132.0 | 39 | 518.1 | 148.5 | 99 | 575.8 | 165.1 |
| 60 | 346.0 | 99.2 | 20 | 403.7 | 115.8 | 80 | 461.4 | 132.3 | 40 | 519.1 | 148.8 | 600 | 576.8 | 165.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

74° (106°, 254°, 286°).

# TABLE 2.

Difference of Latitude and Departure for 17° (163°, 197°, 343°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.3 | 61 | 58.3 | 17.8 | 121 | 115.7 | 35.4 | 181 | 173.1 | 52.9 | 241 | 230.5 | 70.5 |
| 2 | 1.9 | 0.6 | 62 | 59.3 | 18.1 | 22 | 116.7 | 35.7 | 82 | 174.0 | 53.2 | 42 | 231.4 | 70.8 |
| 3 | 2.9 | 0.9 | 63 | 60.2 | 18.4 | 23 | 117.6 | 36.0 | 83 | 175.0 | 53.5 | 43 | 232.4 | 71.0 |
| 4 | 3.8 | 1.2 | 64 | 61.2 | 18.7 | 24 | 118.6 | 36.3 | 84 | 176.0 | 53.8 | 44 | 233.3 | 71.3 |
| 5 | 4.8 | 1.5 | 65 | 62.2 | 19.0 | 25 | 119.5 | 36.5 | 85 | 176.9 | 54.1 | 45 | 234.3 | 71.6 |
| 6 | 5.7 | 1.8 | 66 | 63.1 | 19.3 | 26 | 120.5 | 36.8 | 86 | 177.9 | 54.4 | 46 | 235.3 | 71.9 |
| 7 | 6.7 | 2.0 | 67 | 64.1 | 19.6 | 27 | 121.5 | 37.1 | 87 | 178.8 | 54.7 | 47 | 236.2 | 72.2 |
| 8 | 7.7 | 2.3 | 68 | 65.0 | 19.9 | 28 | 122.4 | 37.4 | 88 | 179.8 | 55.0 | 48 | 237.2 | 72.5 |
| 9 | 8.6 | 2.6 | 69 | 66.0 | 20.2 | 29 | 123.4 | 37.7 | 89 | 180.7 | 55.3 | 49 | 238.1 | 72.8 |
| 10 | 9.6 | 2.9 | 70 | 66.9 | 20.5 | 30 | 124.3 | 38.0 | 90 | 181.7 | 55.6 | 50 | 239.1 | 73.1 |
| 11 | 10.5 | 3.2 | 71 | 67.9 | 20.8 | 131 | 125.3 | 38.3 | 191 | 182.7 | 55.8 | 251 | 240.0 | 73.4 |
| 12 | 11.5 | 3.5 | 72 | 68.9 | 21.1 | 32 | 126.2 | 38.6 | 92 | 183.6 | 56.1 | 52 | 241.0 | 73.7 |
| 13 | 12.4 | 3.8 | 73 | 69.8 | 21.3 | 33 | 127.2 | 38.9 | 93 | 184.6 | 56.4 | 53 | 241.9 | 74.0 |
| 14 | 13.4 | 4.1 | 74 | 70.8 | 21.6 | 34 | 128.1 | 39.2 | 94 | 185.5 | 56.7 | 54 | 242.9 | 74.3 |
| 15 | 14.3 | 4.4 | 75 | 71.7 | 21.9 | 35 | 129.1 | 39.5 | 95 | 186.5 | 57.0 | 55 | 243.9 | 74.6 |
| 16 | 15.3 | 4.7 | 76 | 72.7 | 22.2 | 36 | 130.1 | 39.8 | 96 | 187.4 | 57.3 | 56 | 244.8 | 74.8 |
| 17 | 16.3 | 5.0 | 77 | 73.6 | 22.5 | 37 | 131.0 | 40.1 | 97 | 188.4 | 57.6 | 57 | 245.8 | 75.1 |
| 18 | 17.2 | 5.3 | 78 | 74.6 | 22.8 | 38 | 132.0 | 40.3 | 98 | 189.3 | 57.9 | 58 | 246.7 | 75.4 |
| 19 | 18.2 | 5.6 | 79 | 75.5 | 23.1 | 39 | 132.9 | 40.6 | 99 | 190.3 | 58.2 | 59 | 247.7 | 75.7 |
| 20 | 19.1 | 5.8 | 80 | 76.5 | 23.4 | 40 | 133.9 | 40.9 | 200 | 191.3 | 58.5 | 60 | 248.6 | 76.0 |
| 21 | 20.1 | 6.1 | 81 | 77.5 | 23.7 | 141 | 134.8 | 41.2 | 201 | 192.2 | 58.8 | 261 | 249.6 | 76.3 |
| 22 | 21.0 | 6.4 | 82 | 78.4 | 24.0 | 42 | 135.8 | 41.5 | 02 | 193.2 | 59.1 | 62 | 250.6 | 76.6 |
| 23 | 22.0 | 6.7 | 83 | 79.4 | 24.3 | 43 | 136.8 | 41.8 | 03 | 194.1 | 59.4 | 63 | 251.5 | 76.9 |
| 24 | 23.0 | 7.0 | 84 | 80.3 | 24.6 | 44 | 137.7 | 42.1 | 04 | 195.1 | 59.6 | 64 | 252.5 | 77.2 |
| 25 | 23.9 | 7.3 | 85 | 81.3 | 24.9 | 45 | 138.7 | 42.4 | 05 | 196.0 | 59.9 | 65 | 253.4 | 77.5 |
| 26 | 24.9 | 7.6 | 86 | 82.2 | 25.1 | 46 | 139.6 | 42.7 | 06 | 197.0 | 60.2 | 66 | 254.4 | 77.8 |
| 27 | 25.8 | 7.9 | 87 | 83.2 | 25.4 | 47 | 140.6 | 43.0 | 07 | 198.0 | 60.5 | 67 | 255.3 | 78.1 |
| 28 | 26.8 | 8.2 | 88 | 84.2 | 25.7 | 48 | 141.5 | 43.3 | 08 | 198.9 | 60.8 | 68 | 256.3 | 78.4 |
| 29 | 27.7 | 8.5 | 89 | 85.1 | 26.0 | 49 | 142.5 | 43.6 | 09 | 199.9 | 61.1 | 69 | 257.2 | 78.6 |
| 30 | 28.7 | 8.8 | 90 | 86.1 | 26.3 | 50 | 143.4 | 43.9 | 10 | 200.8 | 61.4 | 70 | 258.2 | 78.9 |
| 31 | 29.6 | 9.1 | 91 | 87.0 | 26.6 | 151 | 144.4 | 44.1 | 211 | 201.8 | 61.7 | 271 | 259.2 | 79.2 |
| 32 | 30.6 | 9.4 | 92 | 88.0 | 26.9 | 52 | 145.4 | 44.4 | 12 | 202.7 | 62.0 | 72 | 260.1 | 79.5 |
| 33 | 31.6 | 9.6 | 93 | 88.9 | 27.2 | 53 | 146.3 | 44.7 | 13 | 203.7 | 62.3 | 73 | 261.1 | 79.8 |
| 34 | 32.5 | 9.9 | 94 | 89.9 | 27.5 | 54 | 147.3 | 45.0 | 14 | 204.6 | 62.6 | 74 | 262.0 | 80.1 |
| 35 | 33.5 | 10.2 | 95 | 90.8 | 27.8 | 55 | 148.2 | 45.3 | 15 | 205.6 | 62.9 | 75 | 263.0 | 80.4 |
| 36 | 34.4 | 10.5 | 96 | 91.8 | 28.1 | 56 | 149.2 | 45.6 | 16 | 206.6 | 63.2 | 76 | 263.9 | 80.7 |
| 37 | 35.4 | 10.8 | 97 | 92.8 | 28.4 | 57 | 150.1 | 45.9 | 17 | 207.5 | 63.4 | 77 | 264.9 | 81.0 |
| 38 | 36.3 | 11.1 | 98 | 93.7 | 28.7 | 58 | 151.1 | 46.2 | 18 | 208.5 | 63.7 | 78 | 265.9 | 81.3 |
| 39 | 37.3 | 11.4 | 99 | 94.7 | 28.9 | 59 | 152.1 | 46.5 | 19 | 209.4 | 64.0 | 79 | 266.8 | 81.6 |
| 40 | 38.3 | 11.7 | 100 | 95.6 | 29.2 | 60 | 153.0 | 46.8 | 20 | 210.4 | 64.3 | 80 | 267.8 | 81.9 |
| 41 | 39.2 | 12.0 | 101 | 96.6 | 29.5 | 161 | 154.0 | 47.1 | 221 | 211.3 | 64.6 | 281 | 268.7 | 82.2 |
| 42 | 40.2 | 12.3 | 02 | 97.5 | 29.8 | 62 | 154.9 | 47.4 | 22 | 212.3 | 64.9 | 82 | 269.7 | 82.4 |
| 43 | 41.1 | 12.6 | 03 | 98.5 | 30.1 | 63 | 155.9 | 47.7 | 23 | 213.3 | 65.2 | 83 | 270.6 | 82.7 |
| 44 | 42.1 | 12.9 | 04 | 99.5 | 30.4 | 64 | 156.8 | 47.9 | 24 | 214.2 | 65.5 | 84 | 271.6 | 83.0 |
| 45 | 43.0 | 13.2 | 05 | 100.4 | 30.7 | 65 | 157.8 | 48.2 | 25 | 215.2 | 65.8 | 85 | 272.5 | 83.3 |
| 46 | 44.0 | 13.4 | 06 | 101.4 | 31.0 | 66 | 158.7 | 48.5 | 26 | 216.1 | 66.1 | 86 | 273.5 | 83.6 |
| 47 | 44.9 | 13.7 | 07 | 102.3 | 31.3 | 67 | 159.7 | 48.8 | 27 | 217.1 | 66.4 | 87 | 274.5 | 83.9 |
| 48 | 45.9 | 14.0 | 08 | 103.3 | 31.6 | 68 | 160.7 | 49.1 | 28 | 218.0 | 66.7 | 88 | 275.4 | 84.2 |
| 49 | 46.9 | 14.3 | 09 | 104.2 | 31.9 | 69 | 161.6 | 49.4 | 29 | 219.0 | 67.0 | 89 | 276.4 | 84.5 |
| 50 | 47.8 | 14.6 | 10 | 105.2 | 32.2 | 70 | 162.6 | 49.7 | 30 | 220.0 | 67.2 | 90 | 277.3 | 84.8 |
| 51 | 48.8 | 14.9 | 111 | 106.1 | 32.5 | 171 | 163.5 | 50.0 | 231 | 220.9 | 67.5 | 291 | 278.3 | 85.1 |
| 52 | 49.7 | 15.2 | 12 | 107.1 | 32.7 | 72 | 164.5 | 50.3 | 32 | 221.9 | 67.8 | 92 | 279.2 | 85.4 |
| 53 | 50.7 | 15.5 | 13 | 108.1 | 33.0 | 73 | 165.4 | 50.6 | 33 | 222.8 | 68.1 | 93 | 280.2 | 85.7 |
| 54 | 51.6 | 15.8 | 14 | 109.0 | 33.3 | 74 | 166.4 | 50.9 | 34 | 223.8 | 68.4 | 94 | 281.2 | 86.0 |
| 55 | 52.6 | 16.1 | 15 | 110.0 | 33.6 | 75 | 167.4 | 51.2 | 35 | 224.7 | 68.7 | 95 | 282.1 | 86.2 |
| 56 | 53.6 | 16.4 | 16 | 110.9 | 33.9 | 76 | 168.3 | 51.5 | 36 | 225.7 | 69.0 | 96 | 283.1 | 86.5 |
| 57 | 54.5 | 16.7 | 17 | 111.9 | 34.2 | 77 | 169.3 | 51.7 | 37 | 226.6 | 69.3 | 97 | 284.0 | 86.8 |
| 58 | 55.5 | 17.0 | 18 | 112.8 | 34.5 | 78 | 170.2 | 52.0 | 38 | 227.6 | 69.6 | 98 | 285.0 | 87.1 |
| 59 | 56.4 | 17.2 | 19 | 113.8 | 34.8 | 79 | 171.2 | 52.3 | 39 | 228.6 | 69.9 | 99 | 285.9 | 87.4 |
| 60 | 57.4 | 17.5 | 20 | 114.8 | 35.1 | 80 | 172.1 | 52.6 | 40 | 229.5 | 70.2 | 300 | 286.9 | 87.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

73° (107°, 253°, 287°).

TABLE 2. [Page 401

Difference of Latitude and Departure for 17° (163°, 197°, 343°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 287.8 | 88.0 | 361 | 345.2 | 105.5 | 421 | 402.6 | 123.1 | 481 | 460.0 | 140.6 | 541 | 517.3 | 158.2 |
| 02 | 288.8 | 88.3 | 62 | 346.1 | 105.8 | 22 | 403.5 | 123.4 | 82 | 460.9 | 140.9 | 42 | 518.3 | 158.5 |
| 03 | 289.7 | 88.6 | 63 | 347.1 | 106.1 | 23 | 404.5 | 123.7 | 83 | 461.9 | 141.2 | 43 | 519.2 | 158.8 |
| 04 | 290.7 | 88.9 | 64 | 348.1 | 106.4 | 24 | 405.4 | 124.0 | 84 | 462.8 | 141.5 | 44 | 520.2 | 159.1 |
| 05 | 291.6 | 89.2 | 65 | 349.0 | 106.7 | 25 | 406.4 | 124.3 | 85 | 463.8 | 141.8 | 45 | 521.2 | 159.3 |
| 06 | 292.6 | 89.5 | 66 | 350.0 | 107.0 | 26 | 407.3 | 124.6 | 86 | 464.7 | 142.1 | 46 | 522.1 | 159.6 |
| 07 | 293.5 | 89.8 | 67 | 350.9 | 107.3 | 27 | 408.3 | 124.8 | 87 | 465.7 | 142.3 | 47 | 523.1 | 159.9 |
| 08 | 294.5 | 90.1 | 68 | 351.9 | 107.6 | 28 | 409.3 | 125.1 | 88 | 466.7 | 142.6 | 48 | 524.0 | 160.2 |
| 09 | 295.5 | 90.3 | 69 | 352.8 | 107.9 | 29 | 410.2 | 125.4 | 89 | 467.6 | 142.9 | 49 | 525.0 | 160.5 |
| 10 | 296.4 | 90.6 | 70 | 353.8 | 108.2 | 30 | 411.2 | 125.7 | 90 | 468.6 | 143.2 | 50 | 526.0 | 160.8 |
| 311 | 297.4 | 90.9 | 371 | 354.8 | 108.5 | 431 | 412.1 | 126.0 | 491 | 469.5 | 143.5 | 551 | 526.9 | 161.1 |
| 12 | 298.3 | 91.2 | 72 | 355.7 | 108.8 | 32 | 413.1 | 126.3 | 92 | 470.5 | 143.8 | 52 | 527.9 | 161.4 |
| 13 | 299.3 | 91.5 | 73 | 356.7 | 109.1 | 33 | 414.0 | 126.6 | 93 | 471.4 | 144.1 | 53 | 528.8 | 161.7 |
| 14 | 300.2 | 91.8 | 74 | 357.6 | 109.4 | 34 | 415.0 | 126.9 | 94 | 472.4 | 144.4 | 54 | 529.8 | 162.0 |
| 15 | 301.2 | 92.1 | 75 | 358.6 | 109.6 | 35 | 416.0 | 127.2 | 95 | 473.4 | 144.7 | 55 | 530.8 | 162.3 |
| 16 | 302.2 | 92.4 | 76 | 359.5 | 109.9 | 36 | 416.9 | 127.5 | 96 | 474.3 | 145.0 | 56 | 531.7 | 162.6 |
| 17 | 303.1 | 92.7 | 77 | 360.5 | 110.2 | 37 | 417.9 | 127.8 | 97 | 475.3 | 145.3 | 57 | 532.7 | 162.9 |
| 18 | 304.1 | 93.0 | 78 | 361.4 | 110.5 | 38 | 418.8 | 128.1 | 98 | 476.2 | 145.6 | 58 | 533.6 | 163.2 |
| 19 | 305.0 | 93.3 | 79 | 362.4 | 110.8 | 39 | 419.8 | 128.4 | 99 | 477.2 | 145.9 | 59 | 534.6 | 163.5 |
| 20 | 306.0 | 93.6 | 80 | 363.4 | 111.1 | 40 | 420.7 | 128.6 | 500 | 478.1 | 146.2 | 60 | 535.5 | 163.8 |
| 321 | 306.9 | 93.9 | 381 | 364.3 | 111.4 | 441 | 421.7 | 128.9 | 501 | 479.1 | 146.5 | 561 | 536.5 | 164.1 |
| 22 | 307.9 | 94.1 | 82 | 365.3 | 111.7 | 42 | 422.7 | 129.2 | 02 | 480.1 | 146.8 | 62 | 537.5 | 164.4 |
| 23 | 308.8 | 94.4 | 83 | 366.2 | 112.0 | 43 | 423.6 | 129.5 | 03 | 481.0 | 147.1 | 63 | 538.4 | 164.6 |
| 24 | 309.8 | 94.7 | 84 | 367.2 | 112.3 | 44 | 424.6 | 129.8 | 04 | 482.0 | 147.4 | 64 | 539.4 | 164.8 |
| 25 | 310.8 | 95.0 | 85 | 368.1 | 112.6 | 45 | 425.5 | 130.1 | 05 | 482.9 | 147.7 | 65 | 540.3 | 165.1 |
| 26 | 311.7 | 95.3 | 86 | 369.1 | 112.9 | 46 | 426.5 | 130.4 | 06 | 483.9 | 148.0 | 66 | 541.3 | 165.4 |
| 27 | 312.7 | 95.6 | 87 | 370.1 | 113.2 | 47 | 427.4 | 130.7 | 07 | 484.8 | 148.3 | 67 | 542.2 | 165.7 |
| 28 | 313.6 | 95.9 | 88 | 371.0 | 113.4 | 48 | 428.4 | 131.0 | 08 | 485.8 | 148.6 | 68 | 543.2 | 166.0 |
| 29 | 314.6 | 96.2 | 89 | 372.0 | 113.7 | 49 | 429.3 | 131.3 | 09 | 486.7 | 148.9 | 69 | 544.1 | 166.4 |
| 30 | 315.5 | 96.5 | 90 | 372.9 | 114.0 | 50 | 430.3 | 131.6 | 10 | 487.7 | 149.1 | 70 | 545.1 | 166.7 |
| 331 | 316.5 | 96.8 | 391 | 373.9 | 114.3 | 451 | 431.3 | 131.9 | 511 | 488.7 | 149.4 | 571 | 546.1 | 167.0 |
| 32 | 317.5 | 97.1 | 92 | 374.8 | 114.6 | 52 | 432.2 | 132.2 | 12 | 489.6 | 149.7 | 72 | 547.0 | 167.2 |
| 33 | 318.4 | 97.4 | 93 | 375.8 | 114.9 | 53 | 433.2 | 132.4 | 13 | 490.6 | 150.0 | 73 | 548.0 | 167.5 |
| 34 | 319.4 | 97.7 | 94 | 376.7 | 115.2 | 54 | 434.1 | 132.7 | 14 | 491.5 | 150.2 | 74 | 548.9 | 167.8 |
| 35 | 320.3 | 97.9 | 95 | 377.7 | 115.5 | 55 | 435.1 | 133.0 | 15 | 492.5 | 150.5 | 75 | 549.9 | 168.1 |
| 36 | 321.3 | 98.2 | 96 | 378.7 | 115.8 | 56 | 436.0 | 133.3 | 16 | 493.4 | 150.8 | 76 | 550.8 | 168.4 |
| 37 | 322.2 | 98.5 | 97 | 379.6 | 116.1 | 57 | 437.0 | 133.6 | 17 | 494.4 | 151.1 | 77 | 551.8 | 168.7 |
| 38 | 323.2 | 98.8 | 98 | 380.6 | 116.4 | 58 | 438.0 | 133.9 | 18 | 495.3 | 151.4 | 78 | 552.7 | 169.0 |
| 39 | 324.2 | 99.1 | 99 | 381.5 | 116.7 | 59 | 438.9 | 134.2 | 19 | 496.3 | 151.7 | 79 | 553.7 | 169.3 |
| 40 | 325.1 | 99.4 | 400 | 382.5 | 117.0 | 60 | 439.9 | 134.5 | 20 | 497.2 | 152.0 | 80 | 554.6 | 169.6 |
| 341 | 326.1 | 99.7 | 401 | 383.4 | 117.2 | 461 | 440.8 | 134.8 | 521 | 498.2 | 152.3 | 581 | 555.6 | 169.9 |
| 42 | 327.0 | 100.0 | 02 | 384.4 | 117.5 | 62 | 441.8 | 135.1 | 22 | 499.2 | 152.6 | 82 | 556.5 | 170.2 |
| 43 | 328.0 | 100.3 | 03 | 385.4 | 117.8 | 63 | 442.7 | 135.4 | 23 | 500.1 | 152.9 | 83 | 557.5 | 170.5 |
| 44 | 328.9 | 100.6 | 04 | 386.3 | 118.1 | 64 | 443.7 | 135.7 | 24 | 501.1 | 153.2 | 84 | 558.4 | 170.8 |
| 45 | 329.9 | 100.9 | 05 | 387.3 | 118.4 | 65 | 444.6 | 136.0 | 25 | 502.0 | 153.5 | 85 | 559.4 | 171.1 |
| 46 | 330.8 | 101.2 | 06 | 388.2 | 118.7 | 66 | 445.6 | 136.2 | 26 | 503.0 | 153.8 | 86 | 560.4 | 171.3 |
| 47 | 331.8 | 101.5 | 07 | 389.2 | 119.0 | 67 | 446.6 | 136.5 | 27 | 503.9 | 154.1 | 87 | 561.3 | 171.6 |
| 48 | 332.8 | 101.8 | 08 | 390.1 | 119.3 | 68 | 447.5 | 136.8 | 28 | 504.9 | 154.4 | 88 | 562.3 | 171.9 |
| 49 | 333.7 | 102.0 | 09 | 391.1 | 119.6 | 69 | 448.5 | 137.1 | 29 | 505.9 | 154.7 | 89 | 563.2 | 172.2 |
| 50 | 334.7 | 102.3 | 10 | 392.0 | 119.9 | 70 | 449.4 | 137.4 | 30 | 506.8 | 155.0 | 90 | 564.2 | 172.5 |
| 351 | 335.6 | 102.6 | 411 | 393.0 | 120.2 | 471 | 450.4 | 137.7 | 531 | 507.8 | 155.3 | 591 | 565.1 | 172.8 |
| 52 | 336.6 | 102.9 | 12 | 394.0 | 120.5 | 72 | 451.3 | 138.0 | 32 | 508.7 | 155.6 | 92 | 566.1 | 173.1 |
| 53 | 337.5 | 103.2 | 13 | 394.9 | 120.8 | 73 | 452.3 | 138.3 | 33 | 509.7 | 155.9 | 93 | 567.1 | 173.4 |
| 54 | 338.5 | 103.5 | 14 | 395.9 | 121.0 | 74 | 453.3 | 138.6 | 34 | 510.6 | 156.2 | 94 | 568.0 | 173.7 |
| 55 | 339.5 | 103.8 | 15 | 396.8 | 121.3 | 75 | 454.2 | 138.9 | 35 | 511.6 | 156.5 | 95 | 569.0 | 174.0 |
| 56 | 340.4 | 104.1 | 16 | 397.8 | 121.6 | 76 | 455.2 | 139.2 | 36 | 512.6 | 156.8 | 96 | 569.9 | 174.3 |
| 57 | 341.4 | 104.4 | 17 | 398.7 | 121.9 | 77 | 456.1 | 139.5 | 37 | 513.5 | 157.1 | 97 | 570.9 | 174.6 |
| 58 | 342.3 | 104.7 | 18 | 399.7 | 122.2 | 78 | 457.1 | 139.8 | 38 | 514.5 | 157.3 | 98 | 571.8 | 174.9 |
| 59 | 343.3 | 105.0 | 19 | 400.7 | 122.5 | 79 | 458.0 | 140.0 | 39 | 515.4 | 157.6 | 99 | 572.8 | 175.2 |
| 60 | 344.2 | 105.3 | 20 | 401.6 | 122.8 | 80 | 459.0 | 140.3 | 40 | 516.4 | 157.9 | 600 | 573.8 | 175.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

73° (107°, 253°, 287°).

## TABLE 2.

### Difference of Latitude and Departure for 18° (162°, 198°, 342°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.3 | 61 | 58.0 | 18.9 | 121 | 115.1 | 37.4 | 181 | 172.1 | 55.9 | 241 | 229.2 | 74.5 |
| 2 | 1.9 | 0.6 | 62 | 59.0 | 19.2 | 22 | 116.0 | 37.7 | 82 | 173.1 | 56.2 | 42 | 230.2 | 74.8 |
| 3 | 2.9 | 0.9 | 63 | 59.9 | 19.5 | 23 | 117.0 | 38.0 | 83 | 174.0 | 56.6 | 43 | 231.1 | 75.1 |
| 4 | 3.8 | 1.2 | 64 | 60.9 | 19.8 | 24 | 117.9 | 38.3 | 84 | 175.0 | 56.9 | 44 | 232.1 | 75.4 |
| 5 | 4.8 | 1.5 | 65 | 61.8 | 20.1 | 25 | 118.9 | 38.6 | 85 | 175.9 | 57.2 | 45 | 233.0 | 75.7 |
| 6 | 5.7 | 1.9 | 66 | 62.8 | 20.4 | 26 | 119.8 | 38.9 | 86 | 176.9 | 57.5 | 46 | 234.0 | 76.0 |
| 7 | 6.7 | 2.2 | 67 | 63.7 | 20.7 | 27 | 120.8 | 39.2 | 87 | 177.8 | 57.8 | 47 | 234.9 | 76.3 |
| 8 | 7.6 | 2.5 | 68 | 64.7 | 21.0 | 28 | 121.7 | 39.6 | 88 | 178.8 | 58.1 | 48 | 235.9 | 76.6 |
| 9 | 8.6 | 2.8 | 69 | 65.6 | 21.3 | 29 | 122.7 | 39.9 | 89 | 179.7 | 58.4 | 49 | 236.8 | 76.9 |
| 10 | 9.5 | 3.1 | 70 | 66.6 | 21.6 | 30 | 123.6 | 40.2 | 90 | 180.7 | 58.7 | 50 | 237.8 | 77.3 |
| 11 | 10.5 | 3.4 | 71 | 67.5 | 21.9 | 131 | 124.6 | 40.5 | 191 | 181.7 | 59.0 | 251 | 238.7 | 77.6 |
| 12 | 11.4 | 3.7 | 72 | 68.5 | 22.2 | 32 | 125.5 | 40.8 | 92 | 182.6 | 59.3 | 52 | 239.7 | 77.9 |
| 13 | 12.4 | 4.0 | 73 | 69.4 | 22.6 | 33 | 126.5 | 41.1 | 93 | 183.6 | 59.6 | 53 | 240.6 | 78.2 |
| 14 | 13.3 | 4.3 | 74 | 70.4 | 22.9 | 34 | 127.4 | 41.4 | 94 | 184.5 | 59.9 | 54 | 241.6 | 78.5 |
| 15 | 14.3 | 4.6 | 75 | 71.3 | 23.2 | 35 | 128.4 | 41.7 | 95 | 185.5 | 60.3 | 55 | 242.5 | 78.8 |
| 16 | 15.2 | 4.9 | 76 | 72.3 | 23.5 | 36 | 129.3 | 42.0 | 96 | 186.4 | 60.6 | 56 | 243.5 | 79.1 |
| 17 | 16.2 | 5.3 | 77 | 73.2 | 23.8 | 37 | 130.3 | 42.3 | 97 | 187.4 | 60.9 | 57 | 244.4 | 79.4 |
| 18 | 17.1 | 5.6 | 78 | 74.2 | 24.1 | 38 | 131.2 | 42.6 | 98 | 188.3 | 61.2 | 58 | 245.4 | 79.7 |
| 19 | 18.1 | 5.9 | 79 | 75.1 | 24.4 | 39 | 132.2 | 43.0 | 99 | 189.3 | 61.5 | 59 | 246.3 | 80.0 |
| 20 | 19.0 | 6.2 | 80 | 76.1 | 24.7 | 40 | 133.1 | 43.3 | 200 | 190.2 | 61.8 | 60 | 247.3 | 80.3 |
| 21 | 20.0 | 6.5 | 81 | 77.0 | 25.0 | 141 | 134.1 | 43.6 | 201 | 191.2 | 62.1 | 261 | 248.2 | 80.7 |
| 22 | 20.9 | 6.8 | 82 | 78.0 | 25.3 | 42 | 135.1 | 43.9 | 02 | 192.1 | 62.4 | 62 | 249.2 | 81.0 |
| 23 | 21.9 | 7.1 | 83 | 78.9 | 25.6 | 43 | 136.0 | 44.2 | 03 | 193.1 | 62.7 | 63 | 250.1 | 81.3 |
| 24 | 22.8 | 7.4 | 84 | 79.9 | 26.0 | 44 | 137.0 | 44.5 | 04 | 194.0 | 63.0 | 64 | 251.1 | 81.6 |
| 25 | 23.8 | 7.7 | 85 | 80.8 | 26.3 | 45 | 137.9 | 44.8 | 05 | 195.0 | 63.3 | 65 | 252.0 | 81.9 |
| 26 | 24.7 | 8.0 | 86 | 81.8 | 26.6 | 46 | 138.9 | 45.1 | 06 | 195.9 | 63.7 | 66 | 253.0 | 82.2 |
| 27 | 25.7 | 8.3 | 87 | 82.7 | 26.9 | 47 | 139.8 | 45.4 | 07 | 196.9 | 64.0 | 67 | 253.9 | 82.5 |
| 28 | 26.6 | 8.7 | 88 | 83.7 | 27.2 | 48 | 140.8 | 45.7 | 08 | 197.8 | 64.3 | 68 | 254.9 | 82.8 |
| 29 | 27.6 | 9.0 | 89 | 84.6 | 27.5 | 49 | 141.7 | 46.0 | 09 | 198.8 | 64.6 | 69 | 255.8 | 83.1 |
| 30 | 28.5 | 9.3 | 90 | 85.6 | 27.8 | 50 | 142.7 | 46.4 | 10 | 199.7 | 64.9 | 70 | 256.8 | 83.4 |
| 31 | 29.5 | 9.6 | 91 | 86.5 | 28.1 | 151 | 143.6 | 46.7 | 211 | 200.7 | 65.2 | 271 | 257.7 | 83.7 |
| 32 | 30.4 | 9.9 | 92 | 87.5 | 28.4 | 52 | 144.6 | 47.0 | 12 | 201.6 | 65.5 | 72 | 258.7 | 84.1 |
| 33 | 31.4 | 10.2 | 93 | 88.4 | 28.7 | 53 | 145.5 | 47.3 | 13 | 202.6 | 65.8 | 73 | 259.6 | 84.4 |
| 34 | 32.3 | 10.5 | 94 | 89.4 | 29.0 | 54 | 146.5 | 47.6 | 14 | 203.5 | 66.1 | 74 | 260.6 | 84.7 |
| 35 | 33.3 | 10.8 | 95 | 90.4 | 29.4 | 55 | 147.4 | 47.9 | 15 | 204.5 | 66.4 | 75 | 261.5 | 85.0 |
| 36 | 34.2 | 11.1 | 96 | 91.3 | 29.7 | 56 | 148.4 | 48.2 | 16 | 205.4 | 66.7 | 76 | 262.5 | 85.3 |
| 37 | 35.2 | 11.4 | 97 | 92.3 | 30.0 | 57 | 149.3 | 48.5 | 17 | 206.4 | 67.1 | 77 | 263.4 | 85.6 |
| 38 | 36.1 | 11.7 | 98 | 93.2 | 30.3 | 58 | 150.3 | 48.8 | 18 | 207.3 | 67.4 | 78 | 264.4 | 85.9 |
| 39 | 37.1 | 12.1 | 99 | 94.2 | 30.6 | 59 | 151.2 | 49.1 | 19 | 208.3 | 67.7 | 79 | 265.3 | 86.2 |
| 40 | 38.0 | 12.4 | 100 | 95.1 | 30.9 | 60 | 152.2 | 49.4 | 20 | 209.2 | 68.0 | 80 | 266.3 | 86.5 |
| 41 | 39.0 | 12.7 | 101 | 96.1 | 31.2 | 161 | 153.1 | 49.8 | 221 | 210.2 | 68.3 | 281 | 267.2 | 86.8 |
| 42 | 39.9 | 13.0 | 02 | 97.0 | 31.5 | 62 | 154.1 | 50.1 | 22 | 211.1 | 68.6 | 82 | 268.2 | 87.1 |
| 43 | 40.9 | 13.3 | 03 | 98.0 | 31.8 | 63 | 155.0 | 50.4 | 23 | 212.1 | 68.9 | 83 | 269.1 | 87.5 |
| 44 | 41.8 | 13.6 | 04 | 98.9 | 32.1 | 64 | 156.0 | 50.7 | 24 | 213.0 | 69.2 | 84 | 270.1 | 87.8 |
| 45 | 42.8 | 13.9 | 05 | 99.9 | 32.4 | 65 | 156.9 | 51.0 | 25 | 214.0 | 69.5 | 85 | 271.1 | 88.1 |
| 46 | 43.7 | 14.2 | 06 | 100.8 | 32.8 | 66 | 157.9 | 51.3 | 26 | 214.9 | 69.8 | 86 | 272.0 | 88.4 |
| 47 | 44.7 | 14.5 | 07 | 101.8 | 33.1 | 67 | 158.8 | 51.6 | 27 | 215.9 | 70.1 | 87 | 273.0 | 88.7 |
| 48 | 45.7 | 14.8 | 08 | 102.7 | 33.4 | 68 | 159.8 | 51.9 | 28 | 216.8 | 70.5 | 88 | 273.9 | 89.0 |
| 49 | 46.6 | 15.1 | 09 | 103.7 | 33.7 | 69 | 160.7 | 52.2 | 29 | 217.8 | 70.8 | 89 | 274.9 | 89.3 |
| 50 | 47.6 | 15.5 | 10 | 104.6 | 34.0 | 70 | 161.7 | 52.5 | 30 | 218.7 | 71.1 | 90 | 275.8 | 89.6 |
| 51 | 48.5 | 15.8 | 111 | 105.6 | 34.3 | 171 | 162.6 | 52.8 | 231 | 219.7 | 71.4 | 291 | 276.8 | 89.9 |
| 52 | 49.5 | 16.1 | 12 | 106.5 | 34.6 | 72 | 163.6 | 53.2 | 32 | 220.6 | 71.7 | 92 | 277.7 | 90.2 |
| 53 | 50.4 | 16.4 | 13 | 107.5 | 34.9 | 73 | 164.5 | 53.5 | 33 | 221.6 | 72.0 | 93 | 278.7 | 90.5 |
| 54 | 51.4 | 16.7 | 14 | 108.4 | 35.2 | 74 | 165.5 | 53.8 | 34 | 222.5 | 72.3 | 94 | 279.6 | 90.9 |
| 55 | 52.3 | 17.0 | 15 | 109.4 | 35.5 | 75 | 166.4 | 54.1 | 35 | 223.5 | 72.6 | 95 | 280.6 | 91.2 |
| 56 | 53.3 | 17.3 | 16 | 110.3 | 35.8 | 76 | 167.4 | 54.4 | 36 | 224.4 | 72.9 | 96 | 281.5 | 91.5 |
| 57 | 54.2 | 17.6 | 17 | 111.3 | 36.2 | 77 | 168.3 | 54.7 | 37 | 225.4 | 73.2 | 97 | 282.5 | 91.8 |
| 58 | 55.2 | 17.9 | 18 | 112.2 | 36.5 | 78 | 169.3 | 55.0 | 38 | 226.4 | 73.5 | 98 | 283.4 | 92.1 |
| 59 | 56.1 | 18.2 | 19 | 113.2 | 36.8 | 79 | 170.2 | 55.3 | 39 | 227.3 | 73.9 | 99 | 284.4 | 92.4 |
| 60 | 57.1 | 18.5 | 20 | 114.1 | 37.1 | 80 | 171.2 | 55.6 | 40 | 228.3 | 74.2 | 300 | 285.3 | 92.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 72° (108°, 252°, 288°).

TABLE 2. [Page 403

Difference of Latitude and Departure for 18° (162°, 198°, 342°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 286.3 | 93.0 | 361 | 343.3 | 111.6 | 421 | 400.4 | 130.1 | 481 | 457.5 | 148.6 | 541 | 514.5 | 167.2 | | | |
| 02 | 287.2 | 93.3 | 62 | 344.3 | 111.9 | 22 | 401.4 | 130.4 | 82 | 458.5 | 148.9 | 42 | 515.5 | 167.5 | | | |
| 03 | 288.2 | 93.7 | 63 | 345.2 | 112.2 | 23 | 402.3 | 130.7 | 83 | 459.4 | 149.3 | 43 | 516.4 | 167.9 | | | |
| 04 | 289.1 | 94.0 | 64 | 346.2 | 112.5 | 24 | 403.3 | 131.0 | 84 | 460.4 | 149.6 | 44 | 517.4 | 168.2 | | | |
| 05 | 290.1 | 94.3 | 65 | 347.1 | 112.8 | 25 | 404.2 | 131.3 | 85 | 461.3 | 149.9 | 45 | 518.3 | 168.5 | | | |
| 06 | 291.0 | 94.6 | 66 | 348.1 | 113.1 | 26 | 405.2 | 131.7 | 86 | 462.3 | 150.2 | 46 | 519.3 | 168.8 | | | |
| 07 | 292.0 | 94.9 | 67 | 349.0 | 113.4 | 27 | 406.1 | 132.0 | 87 | 463.2 | 150.5 | 47 | 520.2 | 169.1 | | | |
| 08 | 292.9 | 95.2 | 68 | 350.0 | 113.7 | 28 | 407.1 | 132.3 | 88 | 464.2 | 150.8 | 48 | 521.2 | 169.4 | | | |
| 09 | 293.9 | 95.5 | 69 | 350.9 | 114.0 | 29 | 408.0 | 132.6 | 89 | 465.1 | 151.1 | 49 | 522.1 | 169.7 | | | |
| 10 | 294.8 | 95.8 | 70 | 351.9 | 114.3 | 30 | 409.0 | 132.9 | 90 | 466.1 | 151.4 | 50 | 523.1 | 170.0 | | | |
| 311 | 295.8 | 96.1 | 371 | 352.9 | 114.7 | 431 | 409.9 | 133.2 | 491 | 467.0 | 151.7 | 551 | 524.0 | 170.3 | | | |
| 12 | 296.7 | 96.4 | 72 | 353.8 | 115.0 | 32 | 410.9 | 133.5 | 92 | 468.0 | 152.0 | 52 | 525.0 | 170.6 | | | |
| 13 | 297.7 | 96.7 | 73 | 354.8 | 115.3 | 33 | 411.8 | 133.8 | 93 | 468.9 | 152.3 | 53 | 525.9 | 170.9 | | | |
| 14 | 298.6 | 97.0 | 74 | 355.7 | 115.6 | 34 | 412.8 | 134.1 | 94 | 469.8 | 152.6 | 54 | 526.9 | 171.2 | | | |
| 15 | 299.6 | 97.4 | 75 | 356.7 | 115.9 | 35 | 413.7 | 134.4 | 95 | 470.8 | 153.0 | 55 | 527.8 | 171.5 | | | |
| 16 | 300.5 | 97.7 | 76 | 357.6 | 116.2 | 36 | 414.7 | 134.7 | 96 | 471.7 | 153.3 | 56 | 528.8 | 171.8 | | | |
| 17 | 301.5 | 98.0 | 77 | 358.6 | 116.5 | 37 | 415.6 | 135.1 | 97 | 472.7 | 153.6 | 57 | 529.7 | 172.1 | | | |
| 18 | 302.4 | 98.3 | 78 | 359.5 | 116.8 | 38 | 416.6 | 135.4 | 98 | 473.6 | 153.9 | 58 | 530.7 | 172.4 | | | |
| 19 | 303.4 | 98.6 | 79 | 360.5 | 117.1 | 39 | 417.5 | 135.7 | 99 | 474.6 | 154.2 | 59 | 531.6 | 172.7 | | | |
| 20 | 304.3 | 98.9 | 80 | 361.4 | 117.4 | 40 | 418.5 | 136.0 | 500 | 475.5 | 154.5 | 60 | 532.6 | 173.0 | | | |
| 321 | 305.3 | 99.2 | 381 | 362.4 | 117.7 | 441 | 419.4 | 136.3 | 501 | 476.5 | 154.8 | 561 | 533.5 | 173.3 | | | |
| 22 | 306.2 | 99.5 | 82 | 363.3 | 118.1 | 42 | 420.4 | 136.6 | 02 | 477.4 | 155.1 | 62 | 534.5 | 173.6 | | | |
| 23 | 307.2 | 99.8 | 83 | 364.3 | 118.4 | 43 | 421.3 | 136.9 | 03 | 478.4 | 155.4 | 63 | 535.4 | 173.9 | | | |
| 24 | 308.2 | 100.1 | 84 | 365.2 | 118.7 | 44 | 422.3 | 137.2 | 04 | 479.3 | 155.7 | 64 | 536.4 | 174.2 | | | |
| 25 | 309.1 | 100.4 | 85 | 366.2 | 119.0 | 45 | 423.2 | 137.5 | 05 | 480.3 | 156.1 | 65 | 537.3 | 174.6 | | | |
| 26 | 310.1 | 100.7 | 86 | 367.1 | 119.3 | 46 | 424.2 | 137.8 | 06 | 481.2 | 156.4 | 66 | 538.3 | 174.9 | | | |
| 27 | 311.0 | 101.1 | 87 | 368.1 | 119.6 | 47 | 425.1 | 138.1 | 07 | 482.2 | 156.7 | 67 | 539.2 | 175.2 | | | |
| 28 | 312.0 | 101.4 | 88 | 369.0 | 119.9 | 48 | 426.1 | 138.4 | 08 | 483.2 | 157.0 | 68 | 540.2 | 175.5 | | | |
| 29 | 312.9 | 101.7 | 89 | 370.0 | 120.2 | 49 | 427.0 | 138.8 | 09 | 484.1 | 157.3 | 69 | 541.1 | 175.8 | | | |
| 30 | 313.9 | 102.0 | 90 | 370.9 | 120.5 | 50 | 428.0 | 139.1 | 10 | 485.1 | 157.6 | 70 | 542.1 | 176.1 | | | |
| 331 | 314.8 | 102.3 | 391 | 371.9 | 120.8 | 451 | 428.9 | 139.4 | 511 | 486.0 | 157.9 | 571 | 543.0 | 176.4 | | | |
| 32 | 315.8 | 102.6 | 92 | 372.8 | 121.1 | 52 | 429.9 | 139.7 | 12 | 487.0 | 158.2 | 72 | 544.0 | 176.7 | | | |
| 33 | 316.7 | 102.9 | 93 | 373.8 | 121.5 | 53 | 430.8 | 140.0 | 13 | 487.9 | 158.5 | 73 | 544.9 | 177.0 | | | |
| 34 | 317.7 | 103.2 | 94 | 374.7 | 121.8 | 54 | 431.8 | 140.3 | 14 | 488.9 | 158.8 | 74 | 545.9 | 177.3 | | | |
| 35 | 318.6 | 103.5 | 95 | 375.7 | 122.1 | 55 | 432.7 | 140.6 | 15 | 489.8 | 159.1 | 75 | 546.8 | 177.6 | | | |
| 36 | 319.6 | 103.8 | 96 | 376.6 | 122.4 | 56 | 433.7 | 140.9 | 16 | 490.8 | 159.4 | 76 | 547.8 | 178.0 | | | |
| 37 | 320.5 | 104.1 | 97 | 377.6 | 122.7 | 57 | 434.6 | 141.2 | 17 | 491.7 | 159.7 | 77 | 548.7 | 178.3 | | | |
| 38 | 321.5 | 104.5 | 98 | 378.5 | 123.0 | 58 | 435.6 | 141.5 | 18 | 492.7 | 160.0 | 78 | 549.7 | 178.6 | | | |
| 39 | 322.4 | 104.8 | 99 | 379.5 | 123.3 | 59 | 436.5 | 141.8 | 19 | 493.6 | 160.3 | 79 | 550.6 | 178.9 | | | |
| 40 | 323.4 | 105.1 | 400 | 380.4 | 123.6 | 60 | 437.5 | 142.2 | 20 | 494.6 | 160.7 | 80 | 551.6 | 179.2 | | | |
| 341 | 324.3 | 105.4 | 401 | 381.4 | 123.9 | 461 | 438.4 | 142.5 | 521 | 495.5 | 161.0 | 581 | 552.5 | 179.5 | | | |
| 42 | 325.3 | 105.7 | 02 | 382.3 | 124.2 | 62 | 439.4 | 142.8 | 22 | 496.5 | 161.3 | 82 | 553.5 | 179.8 | | | |
| 43 | 326.2 | 106.0 | 03 | 383.3 | 124.5 | 63 | 440.3 | 143.1 | 23 | 497.4 | 161.6 | 83 | 554.4 | 180.1 | | | |
| 44 | 327.2 | 106.3 | 04 | 384.2 | 124.9 | 64 | 441.3 | 143.4 | 24 | 498.4 | 161.9 | 84 | 555.4 | 180.4 | | | |
| 45 | 328.1 | 106.6 | 05 | 385.2 | 125.2 | 65 | 442.2 | 143.7 | 25 | 499.3 | 162.2 | 85 | 556.3 | 180.7 | | | |
| 46 | 329.1 | 106.9 | 06 | 386.1 | 125.5 | 66 | 443.2 | 144.0 | 26 | 500.3 | 162.5 | 86 | 557.3 | 181.1 | | | |
| 47 | 330.0 | 107.2 | 07 | 387.1 | 125.8 | 67 | 444.2 | 144.3 | 27 | 501.2 | 162.9 | 87 | 558.2 | 181.4 | | | |
| 48 | 331.0 | 107.5 | 08 | 388.0 | 126.1 | 68 | 445.1 | 144.6 | 28 | 502.2 | 163.2 | 88 | 559.2 | 181.7 | | | |
| 49 | 331.9 | 107.9 | 09 | 389.0 | 126.4 | 69 | 446.1 | 144.9 | 29 | 503.1 | 163.5 | 89 | 560.1 | 182.0 | | | |
| 50 | 332.9 | 108.2 | 10 | 389.9 | 126.7 | 70 | 447.0 | 145.2 | 30 | 504.1 | 163.8 | 90 | 561.1 | 182.3 | | | |
| 351 | 333.8 | 108.5 | 411 | 390.9 | 127.0 | 471 | 448.0 | 145.6 | 531 | 505.0 | 164.1 | 591 | 562.0 | 182.7 | | | |
| 52 | 334.8 | 108.8 | 12 | 391.8 | 127.3 | 72 | 448.9 | 145.9 | 32 | 506.0 | 164.4 | 92 | 563.0 | 183.0 | | | |
| 53 | 335.7 | 109.1 | 13 | 392.8 | 127.6 | 73 | 449.9 | 146.2 | 33 | 506.9 | 164.7 | 93 | 563.9 | 183.3 | | | |
| 54 | 336.7 | 109.4 | 14 | 393.7 | 127.9 | 74 | 450.8 | 146.5 | 34 | 507.9 | 165.0 | 94 | 564.9 | 183.6 | | | |
| 55 | 337.6 | 109.7 | 15 | 394.7 | 128.3 | 75 | 451.8 | 146.8 | 35 | 508.8 | 165.3 | 95 | 565.8 | 183.9 | | | |
| 56 | 338.6 | 110.0 | 16 | 395.6 | 128.6 | 76 | 452.7 | 147.1 | 36 | 509.8 | 165.6 | 96 | 566.8 | 184.2 | | | |
| 57 | 339.5 | 110.3 | 17 | 396.6 | 128.9 | 77 | 453.7 | 147.4 | 37 | 510.7 | 165.9 | 97 | 567.7 | 184.5 | | | |
| 58 | 340.5 | 110.6 | 18 | 397.5 | 129.2 | 78 | 454.6 | 147.7 | 38 | 511.7 | 166.2 | 98 | 568.7 | 184.8 | | | |
| 59 | 341.4 | 110.9 | 19 | 398.5 | 129.5 | 79 | 455.6 | 148.0 | 39 | 512.6 | 166.5 | 99 | 569.6 | 185.1 | | | |
| 60 | 342.4 | 111.3 | 20 | 399.5 | 129.8 | 80 | 456.5 | 148.3 | 40 | 513.6 | 166.9 | 600 | 570.6 | 185.4 | | | |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

72° (108, 252°, 288°).

# TABLE 2.

Difference of Latitude and Departure for 19° (161°, 199°, 341°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.3 | 61 | 57.7 | 19.9 | 121 | 114.4 | 39.4 | 181 | 171.1 | 58.9 | 241 | 227.9 | 78.5 |
| 2 | 1.9 | 0.7 | 62 | 58.6 | 20.2 | 22 | 115.4 | 39.7 | 82 | 172.1 | 59.3 | 42 | 228.8 | 78.8 |
| 3 | 2.8 | 1.0 | 63 | 59.6 | 20.5 | 23 | 116.3 | 40.0 | 83 | 173.0 | 59.6 | 43 | 229.8 | 79.1 |
| 4 | 3.8 | 1.3 | 64 | 60.5 | 20.8 | 24 | 117.2 | 40.4 | 84 | 174.0 | 59.9 | 44 | 230.7 | 79.4 |
| 5 | 4.7 | 1.6 | 65 | 61.5 | 21.2 | 25 | 118.2 | 40.7 | 85 | 174.9 | 60.2 | 45 | 231.7 | 79.8 |
| 6 | 5.7 | 2.0 | 66 | 62.4 | 21.5 | 26 | 119.1 | 41.0 | 86 | 175.9 | 60.6 | 46 | 232.6 | 80.1 |
| 7 | 6.6 | 2.3 | 67 | 63.3 | 21.8 | 27 | 120.1 | 41.3 | 87 | 176.8 | 60.9 | 47 | 233.5 | 80.4 |
| 8 | 7.6 | 2.6 | 68 | 64.3 | 22.1 | 28 | 121.0 | 41.7 | 88 | 177.8 | 61.2 | 48 | 234.5 | 80.7 |
| 9 | 8.5 | 2.9 | 69 | 65.2 | 22.5 | 29 | 122.0 | 42.0 | 89 | 178.7 | 61.5 | 49 | 235.4 | 81.1 |
| 10 | 9.5 | 3.3 | 70 | 66.2 | 22.8 | 30 | 122.9 | 42.3 | 90 | 179.6 | 61.9 | 50 | 236.4 | 81.4 |
| 11 | 10.4 | 3.6 | 71 | 67.1 | 23.1 | 131 | 123.9 | 42.6 | 191 | 180.6 | 62.2 | 251 | 237.3 | 81.7 |
| 12 | 11.3 | 3.9 | 72 | 68.1 | 23.4 | 32 | 124.8 | 43.0 | 92 | 181.5 | 62.5 | 52 | 238.3 | 82.0 |
| 13 | 12.3 | 4.2 | 73 | 69.0 | 23.8 | 33 | 125.8 | 43.3 | 93 | 182.5 | 62.8 | 53 | 239.2 | 82.4 |
| 14 | 13.2 | 4.6 | 74 | 70.0 | 24.1 | 34 | 126.7 | 43.6 | 94 | 183.4 | 63.2 | 54 | 240.2 | 82.7 |
| 15 | 14.2 | 4.9 | 75 | 70.9 | 24.4 | 35 | 127.6 | 44.0 | 95 | 184.4 | 63.5 | 55 | 241.1 | 83.0 |
| 16 | 15.1 | 5.2 | 76 | 71.9 | 24.7 | 36 | 128.6 | 44.3 | 96 | 185.3 | 63.8 | 56 | 242.1 | 83.3 |
| 17 | 16.1 | 5.5 | 77 | 72.8 | 25.1 | 37 | 129.5 | 44.6 | 97 | 186.3 | 64.1 | 57 | 243.0 | 83.7 |
| 18 | 17.0 | 5.9 | 78 | 73.8 | 25.4 | 38 | 130.5 | 44.9 | 98 | 187.2 | 64.5 | 58 | 243.9 | 84.0 |
| 19 | 18.0 | 6.2 | 79 | 74.7 | 25.7 | 39 | 131.4 | 45.3 | 99 | 188.2 | 64.8 | 59 | 244.9 | 84.3 |
| 20 | 18.9 | 6.5 | 80 | 75.6 | 26.0 | 40 | 132.4 | 45.6 | 200 | 189.1 | 65.1 | 60 | 245.8 | 84.6 |
| 21 | 19.9 | 6.8 | 81 | 76.6 | 26.4 | 141 | 133.3 | 45.9 | 201 | 190.0 | 65.4 | 261 | 246.8 | 85.0 |
| 22 | 20.8 | 7.2 | 82 | 77.5 | 26.7 | 42 | 134.3 | 46.2 | 02 | 191.0 | 65.8 | 62 | 247.7 | 85.3 |
| 23 | 21.7 | 7.5 | 83 | 78.5 | 27.0 | 43 | 135.2 | 46.6 | 03 | 191.9 | 66.1 | 63 | 248.7 | 85.6 |
| 24 | 22.7 | 7.8 | 84 | 79.4 | 27.3 | 44 | 136.2 | 46.9 | 04 | 192.9 | 66.4 | 64 | 249.6 | 86.0 |
| 25 | 23.6 | 8.1 | 85 | 80.4 | 27.7 | 45 | 137.1 | 47.2 | 05 | 193.8 | 66.7 | 65 | 250.6 | 86.3 |
| 26 | 24.6 | 8.5 | 86 | 81.3 | 28.0 | 46 | 138.0 | 47.5 | 06 | 194.8 | 67.1 | 66 | 251.5 | 86.6 |
| 27 | 25.5 | 8.8 | 87 | 82.3 | 28.3 | 47 | 139.0 | 47.9 | 07 | 195.7 | 67.4 | 67 | 252.5 | 86.9 |
| 28 | 26.5 | 9.1 | 88 | 83.2 | 28.7 | 48 | 139.9 | 48.2 | 08 | 196.7 | 67.7 | 68 | 253.4 | 87.3 |
| 29 | 27.4 | 9.4 | 89 | 84.2 | 29.0 | 49 | 140.9 | 48.5 | 09 | 197.6 | 68.0 | 69 | 254.3 | 87.6 |
| 30 | 28.4 | 9.8 | 90 | 85.1 | 29.3 | 50 | 141.8 | 48.8 | 10 | 198.6 | 68.4 | 70 | 255.3 | 87.9 |
| 31 | 29.3 | 10.1 | 91 | 86.0 | 29.6 | 151 | 142.8 | 49.2 | 211 | 199.5 | 68.7 | 271 | 256.2 | 88.2 |
| 32 | 30.3 | 10.4 | 92 | 87.0 | 30.0 | 52 | 143.7 | 49.5 | 12 | 200.4 | 69.0 | 72 | 257.2 | 88.6 |
| 33 | 31.2 | 10.7 | 93 | 87.9 | 30.3 | 53 | 144.7 | 49.8 | 13 | 201.4 | 69.3 | 73 | 258.1 | 88.9 |
| 34 | 32.1 | 11.1 | 94 | 88.9 | 30.6 | 54 | 145.6 | 50.1 | 14 | 202.3 | 69.7 | 74 | 259.1 | 89.2 |
| 35 | 33.1 | 11.4 | 95 | 89.8 | 30.9 | 55 | 146.6 | 50.5 | 15 | 203.3 | 70.0 | 75 | 260.0 | 89.5 |
| 36 | 34.0 | 11.7 | 96 | 90.8 | 31.3 | 56 | 147.5 | 50.8 | 16 | 204.2 | 70.3 | 76 | 261.0 | 89.9 |
| 37 | 35.0 | 12.0 | 97 | 91.7 | 31.6 | 57 | 148.4 | 51.1 | 17 | 205.2 | 70.6 | 77 | 261.9 | 90.2 |
| 38 | 35.9 | 12.4 | 98 | 92.7 | 31.9 | 58 | 149.4 | 51.4 | 18 | 206.1 | 71.0 | 78 | 262.9 | 90.5 |
| 39 | 36.9 | 12.7 | 99 | 93.6 | 32.2 | 59 | 150.3 | 51.8 | 19 | 207.1 | 71.3 | 79 | 263.8 | 90.8 |
| 40 | 37.8 | 13.0 | 100 | 94.6 | 32.6 | 60 | 151.3 | 52.1 | 20 | 208.0 | 71.6 | 80 | 264.7 | 91.2 |
| 41 | 38.8 | 13.3 | 101 | 95.5 | 32.9 | 161 | 152.2 | 52.4 | 221 | 209.0 | 72.0 | 281 | 265.7 | 91.5 |
| 42 | 39.7 | 13.7 | 02 | 96.4 | 33.2 | 62 | 153.2 | 52.7 | 22 | 209.9 | 72.3 | 82 | 266.6 | 91.8 |
| 43 | 40.7 | 14.0 | 03 | 97.4 | 33.5 | 63 | 154.1 | 53.1 | 23 | 210.9 | 72.6 | 83 | 267.6 | 92.1 |
| 44 | 41.6 | 14.3 | 04 | 98.3 | 33.9 | 64 | 155.1 | 53.4 | 24 | 211.8 | 72.9 | 84 | 268.5 | 92.5 |
| 45 | 42.5 | 14.7 | 05 | 99.3 | 34.2 | 65 | 156.0 | 53.7 | 25 | 212.7 | 73.3 | 85 | 269.5 | 92.8 |
| 46 | 43.5 | 15.0 | 06 | 100.2 | 34.5 | 66 | 157.0 | 54.0 | 26 | 213.7 | 73.6 | 86 | 270.4 | 93.1 |
| 47 | 44.4 | 15.3 | 07 | 101.2 | 34.8 | 67 | 157.9 | 54.4 | 27 | 214.6 | 73.9 | 87 | 271.4 | 93.4 |
| 48 | 45.4 | 15.6 | 08 | 102.1 | 35.2 | 68 | 158.8 | 54.7 | 28 | 215.6 | 74.2 | 88 | 272.3 | 93.8 |
| 49 | 46.3 | 16.0 | 09 | 103.1 | 35.5 | 69 | 159.8 | 55.0 | 29 | 216.5 | 74.6 | 89 | 273.3 | 94.1 |
| 50 | 47.3 | 16.3 | 10 | 104.0 | 35.8 | 70 | 160.7 | 55.3 | 30 | 217.5 | 74.9 | 90 | 274.2 | 94.4 |
| 51 | 48.2 | 16.6 | 111 | 105.0 | 36.1 | 171 | 161.7 | 55.7 | 231 | 218.4 | 75.2 | 291 | 275.1 | 94.7 |
| 52 | 49.2 | 16.9 | 12 | 105.9 | 36.5 | 72 | 162.6 | 56.0 | 32 | 219.4 | 75.5 | 92 | 276.1 | 95.1 |
| 53 | 50.1 | 17.3 | 13 | 106.8 | 36.8 | 73 | 163.6 | 56.3 | 33 | 220.3 | 75.9 | 93 | 277.0 | 95.4 |
| 54 | 51.1 | 17.6 | 14 | 107.8 | 37.1 | 74 | 164.5 | 56.6 | 34 | 221.3 | 76.2 | 94 | 278.0 | 95.7 |
| 55 | 52.0 | 17.9 | 15 | 108.7 | 37.4 | 75 | 165.5 | 57.0 | 35 | 222.2 | 76.5 | 95 | 278.9 | 96.0 |
| 56 | 52.9 | 18.2 | 16 | 109.7 | 37.8 | 76 | 166.4 | 57.3 | 36 | 223.1 | 76.8 | 96 | 279.9 | 96.4 |
| 57 | 53.9 | 18.6 | 17 | 110.6 | 38.1 | 77 | 167.4 | 57.6 | 37 | 224.1 | 77.2 | 97 | 280.8 | 96.7 |
| 58 | 54.8 | 18.9 | 18 | 111.6 | 38.4 | 78 | 168.3 | 58.0 | 38 | 225.0 | 77.5 | 98 | 281.8 | 97.0 |
| 59 | 55.8 | 19.2 | 19 | 112.5 | 38.7 | 79 | 169.2 | 58.3 | 39 | 226.0 | 77.8 | 99 | 282.7 | 97.3 |
| 60 | 56.7 | 19.5 | 20 | 113.5 | 39.1 | 80 | 170.2 | 58.6 | 40 | 226.9 | 78.1 | 300 | 283.7 | 97.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

71° (109°, 251°, 289°).

TABLE 2. [Page 405

Difference of Latitude and Departure for 19° (161°, 199°, 341°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 284.6 | 98.0 | 361 | 341.3 | 117.5 | 421 | 398.1 | 137.0 | 481 | 454.8 | 156.6 | 541 | 511.5 | 176.1 |
| 02 | 285.5 | 98.3 | 62 | 342.3 | 117.8 | 22 | 399.0 | 137.4 | 82 | 455.7 | 156.9 | 42 | 512.4 | 176.4 |
| 03 | 286.5 | 98.6 | 63 | 343.2 | 118.2 | 23 | 400.0 | 137.7 | 83 | 456.7 | 157.2 | 43 | 513.4 | 176.8 |
| 04 | 287.4 | 99.0 | 64 | 344.2 | 118.5 | 24 | 400.9 | 138.0 | 84 | 457.6 | 157.6 | 44 | 514.3 | 177.1 |
| 05 | 288.4 | 99.3 | 65 | 345.1 | 118.8 | 25 | 401.8 | 138.4 | 85 | 458.6 | 157.9 | 45 | 515.3 | 177.4 |
| 06 | 289.3 | 99.6 | 66 | 346.1 | 119.1 | 26 | 402.8 | 138.7 | 86 | 459.5 | 158.2 | 46 | 516.2 | 177.7 |
| 07 | 290.3 | 99.9 | 67 | 347.0 | 119.5 | 27 | 403.7 | 139.0 | 87 | 460.5 | 158.5 | 47 | 517.2 | 178.1 |
| 08 | 291.2 | 100.3 | 68 | 348.0 | 119.8 | 28 | 404.7 | 139.3 | 88 | 461.4 | 158.9 | 48 | 518.1 | 178.4 |
| 09 | 292.2 | 100.6 | 69 | 348.9 | 120.1 | 29 | 405.6 | 139.7 | 89 | 462.4 | 159.2 | 49 | 519.1 | 178.7 |
| 10 | 293.1 | 100.9 | 70 | 349.8 | 120.4 | 30 | 406.6 | 140.0 | 90 | 463.3 | 159.5 | 50 | 520.0 | 179.0 |
| 311 | 294.1 | 101.2 | 371 | 350.8 | 120.8 | 431 | 407.5 | 140.3 | 491 | 464.3 | 159.8 | 551 | 521.0 | 179.4 |
| 12 | 295.0 | 101.6 | 72 | 351.7 | 121.1 | 32 | 408.5 | 140.6 | 92 | 465.2 | 160.2 | 52 | 521.9 | 179.7 |
| 13 | 295.9 | 101.9 | 73 | 352.7 | 121.4 | 33 | 409.4 | 141.0 | 93 | 466.1 | 160.5 | 53 | 522.8 | 180.0 |
| 14 | 296.9 | 102.2 | 74 | 353.6 | 121.7 | 34 | 410.4 | 141.3 | 94 | 467.1 | 160.8 | 54 | 523.8 | 180.3 |
| 15 | 297.8 | 102.5 | 75 | 354.6 | 122.1 | 35 | 411.3 | 141.6 | 95 | 468.0 | 161.1 | 55 | 524.7 | 180.7 |
| 16 | 298.8 | 102.9 | 76 | 355.5 | 122.4 | 36 | 412.2 | 141.9 | 96 | 469.0 | 161.5 | 56 | 525.7 | 181.0 |
| 17 | 299.7 | 103.2 | 77 | 356.5 | 122.7 | 37 | 413.2 | 142.3 | 97 | 469.9 | 161.8 | 57 | 526.6 | 181.3 |
| 18 | 300.7 | 103.5 | 78 | 357.4 | 123.0 | 38 | 414.1 | 142.6 | 98 | 470.9 | 162.1 | 58 | 527.6 | 181.6 |
| 19 | 301.6 | 103.8 | 79 | 358.4 | 123.4 | 39 | 415.1 | 142.9 | 99 | 471.8 | 162.4 | 59 | 528.5 | 182.0 |
| 20 | 302.6 | 104.2 | 80 | 359.3 | 123.7 | 40 | 416.0 | 143.2 | 500 | 472.8 | 162.8 | 60 | 529.5 | 182.3 |
| 321 | 303.5 | 104.5 | 381 | 360.2 | 124.0 | 441 | 417.0 | 143.6 | 501 | 473.7 | 163.1 | 561 | 530.4 | 182.6 |
| 22 | 304.5 | 104.8 | 82 | 361.2 | 124.4 | 42 | 417.9 | 143.9 | 02 | 474.7 | 163.4 | 62 | 531.4 | 182.9 |
| 23 | 305.4 | 105.1 | 83 | 362.1 | 124.7 | 43 | 418.9 | 144.2 | 03 | 475.6 | 163.7 | 63 | 532.3 | 183.3 |
| 24 | 306.3 | 105.5 | 84 | 363.1 | 125.0 | 44 | 419.8 | 144.5 | 04 | 476.5 | 164.1 | 64 | 533.2 | 183.6 |
| 25 | 307.3 | 105.8 | 85 | 364.0 | 125.3 | 45 | 420.8 | 144.9 | 05 | 477.5 | 164.4 | 65 | 534.2 | 183.9 |
| 26 | 308.2 | 106.1 | 86 | 365.0 | 125.7 | 46 | 421.7 | 145.2 | 06 | 478.4 | 164.7 | 66 | 535.1 | 184.2 |
| 27 | 309.2 | 106.4 | 87 | 365.9 | 126.0 | 47 | 422.6 | 145.5 | 07 | 479.4 | 165.0 | 67 | 536.1 | 184.6 |
| 28 | 310.1 | 106.8 | 88 | 366.9 | 126.3 | 48 | 423.6 | 145.8 | 08 | 480.3 | 165.4 | 68 | 537.0 | 184.9 |
| 29 | 311.1 | 107.1 | 89 | 367.8 | 126.6 | 49 | 424.5 | 146.2 | 09 | 481.2 | 165.7 | 69 | 538.0 | 185.2 |
| 30 | 312.0 | 107.4 | 90 | 368.8 | 127.0 | 50 | 425.5 | 146.5 | 10 | 482.2 | 166.1 | 70 | 538.9 | 185.6 |
| 331 | 313.0 | 107.7 | 391 | 369.7 | 127.3 | 451 | 426.4 | 146.8 | 511 | 483.1 | 166.4 | 571 | 539.9 | 185.9 |
| 32 | 313.9 | 108.1 | 92 | 370.6 | 127.6 | 52 | 427.4 | 147.1 | 12 | 484.1 | 166.7 | 72 | 540.8 | 186.2 |
| 33 | 314.9 | 108.4 | 93 | 371.6 | 127.9 | 53 | 428.3 | 147.5 | 13 | 485.0 | 167.0 | 73 | 541.7 | 186.5 |
| 34 | 315.8 | 108.7 | 94 | 372.5 | 128.3 | 54 | 429.3 | 147.8 | 14 | 486.0 | 167.4 | 74 | 542.7 | 186.9 |
| 35 | 316.7 | 109.1 | 95 | 373.5 | 128.6 | 55 | 430.2 | 148.1 | 15 | 486.9 | 167.7 | 75 | 543.6 | 187.2 |
| 36 | 317.7 | 109.4 | 96 | 374.4 | 128.9 | 56 | 431.2 | 148.4 | 16 | 487.9 | 168.0 | 76 | 544.6 | 187.5 |
| 37 | 318.6 | 109.7 | 97 | 375.4 | 129.2 | 57 | 432.1 | 148.8 | 17 | 488.8 | 168.3 | 77 | 545.5 | 187.8 |
| 38 | 319.6 | 110.0 | 98 | 376.3 | 129.6 | 58 | 433.0 | 149.1 | 18 | 489.7 | 168.7 | 78 | 546.5 | 188.2 |
| 39 | 320.5 | 110.4 | 99 | 377.3 | 129.9 | 59 | 434.0 | 149.4 | 19 | 490.7 | 169.0 | 79 | 547.4 | 188.5 |
| 40 | 321.5 | 110.7 | 400 | 378.2 | 130.2 | 60 | 434.9 | 149.7 | 20 | 491.6 | 169.3 | 80 | 548.4 | 188.8 |
| 341 | 322.4 | 111.0 | 401 | 379.2 | 130.5 | 461 | 435.9 | 150.1 | 521 | 492.6 | 169.6 | 581 | 549.3 | 189.1 |
| 42 | 323.4 | 111.3 | 02 | 380.1 | 130.9 | 62 | 436.8 | 150.4 | 22 | 493.5 | 170.0 | 82 | 550.3 | 189.5 |
| 43 | 324.3 | 111.7 | 03 | 381.0 | 131.2 | 63 | 437.8 | 150.7 | 23 | 494.5 | 170.3 | 83 | 551.2 | 189.8 |
| 44 | 825.3 | 112.0 | 04 | 382.0 | 131.5 | 64 | 438.7 | 151.0 | 24 | 495.4 | 170.6 | 84 | 552.2 | 190.1 |
| 45 | 326.2 | 112.3 | 05 | 382.9 | 131.8 | 65 | 439.7 | 151.4 | 25 | 496.4 | 170.9 | 85 | 553.1 | 190.4 |
| 46 | 327.1 | 112.6 | 06 | 383.9 | 132.2 | 66 | 440.6 | 151.7 | 26 | 497.3 | 171.2 | 86 | 554.1 | 190.8 |
| 47 | 328.1 | 113.0 | 07 | 384.8 | 132.5 | 67 | 441.6 | 152.0 | 27 | 498.3 | 171.6 | 87 | 555.0 | 191.1 |
| 48 | 329.0 | 113.3 | 08 | 385.8 | 132.8 | 68 | 442.5 | 152.4 | 28 | 499.2 | 171.9 | 88 | 555.9 | 191.4 |
| 49 | 330.0 | 113.6 | 09 | 386.7 | 133.1 | 69 | 443.4 | 152.7 | 29 | 500.1 | 172.2 | 89 | 556.9 | 191.7 |
| 50 | 330.9 | 113.9 | 10 | 387.7 | 133.5 | 70 | 444.4 | 153.0 | 30 | 501.1 | 172.5 | 90 | 557.8 | 192.1 |
| 351 | 331.9 | 114.3 | 411 | 388.6 | 133.8 | 471 | 445.3 | 153.3 | 531 | 502.0 | 172.9 | 591 | 558.8 | 192.4 |
| 52 | 332.8 | 114.6 | 12 | 389.6 | 134.1 | 72 | 446.3 | 153.7 | 32 | 503.0 | 173.2 | 92 | 559.7 | 192.7 |
| 53 | 333.8 | 114.9 | 13 | 390.5 | 134.4 | 73 | 447.2 | 154.0 | 33 | 503.9 | 173.5 | 93 | 560.7 | 193.0 |
| 54 | 334.7 | 115.2 | 14 | 391.4 | 134.8 | 74 | 448.2 | 154.3 | 34 | 504.9 | 173.8 | 94 | 561.6 | 193.4 |
| 55 | 335.7 | 115.6 | 15 | 392.4 | 135.1 | 75 | 449.1 | 154.6 | 35 | 505.8 | 174.2 | 95 | 562.6 | 193.7 |
| 56 | 336.6 | 115.9 | 16 | 393.3 | 135.4 | 76 | 450.1 | 155.0 | 36 | 506.8 | 174.5 | 96 | 563.5 | 194.0 |
| 57 | 337.5 | 116.2 | 17 | 394.3 | 135.7 | 77 | 451.0 | 155.3 | 37 | 507.7 | 174.8 | 97 | 564.5 | 194.3 |
| 58 | 338.5 | 116.5 | 18 | 395.2 | 136.1 | 78 | 452.0 | 155.6 | 38 | 508.7 | 175.1 | 98 | 565.4 | 194.7 |
| 59 | 339.4 | 116.9 | 19 | 396.2 | 136.4 | 79 | 452.9 | 155.9 | 39 | 509.6 | 175.5 | 99 | 566.4 | 195.0 |
| 60 | 340.4 | 117.2 | 20 | 397.1 | 136.7 | 80 | 453.8 | 156.3 | 40 | 510.6 | 175.8 | 600 | 567.3 | 195.3 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

71° (109°, 251°, 289°).

# TABLE 2.

Difference of Latitude and Departure for 20° (160°, 200°, 340°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.3 | 61 | 57.3 | 20.9 | 121 | 113.7 | 41.4 | 181 | 170.1 | 61.9 | 241 | 226.5 | 82.4 |
| 2 | 1.9 | 0.7 | 62 | 58.3 | 21.2 | 22 | 114.6 | 41.7 | 82 | 171.0 | 62.2 | 42 | 227.4 | 82.8 |
| 3 | 2.8 | 1.0 | 63 | 59.2 | 21.5 | 23 | 115.6 | 42.1 | 83 | 172.0 | 62.6 | 43 | 228.3 | 83.1 |
| 4 | 3.8 | 1.4 | 64 | 60.1 | 21.9 | 24 | 116.5 | 42.4 | 84 | 172.9 | 62.9 | 44 | 229.3 | 83.5 |
| 5 | 4.7 | 1.7 | 65 | 61.1 | 22.2 | 25 | 117.5 | 42.8 | 85 | 173.8 | 63.3 | 45 | 230.2 | 83.8 |
| 6 | 5.6 | 2.1 | 66 | 62.0 | 22.6 | 26 | 118.4 | 43.1 | 86 | 174.8 | 63.6 | 46 | 231.2 | 84.1 |
| 7 | 6.6 | 2.4 | 67 | 63.0 | 22.9 | 27 | 119.3 | 43.4 | 87 | 175.7 | 64.0 | 47 | 232.1 | 84.5 |
| 8 | 7.5 | 2.7 | 68 | 63.9 | 23.3 | 28 | 120.3 | 43.8 | 88 | 176.7 | 64.3 | 48 | 233.0 | 84.8 |
| 9 | 8.5 | 3.1 | 69 | 64.8 | 23.6 | 29 | 121.2 | 44.1 | 89 | 177.6 | 64.6 | 49 | 234.0 | 85.2 |
| 10 | 9.4 | 3.4 | 70 | 65.8 | 23.9 | 30 | 122.2 | 44.5 | 90 | 178.5 | 65.0 | 50 | 234.9 | 85.5 |
| 11 | 10.3 | 3.8 | 71 | 66.7 | 24.3 | 131 | 123.1 | 44.8 | 191 | 179.5 | 65.3 | 251 | 235.9 | 85.8 |
| 12 | 11.3 | 4.1 | 72 | 67.7 | 24.6 | 32 | 124.0 | 45.1 | 92 | 180.4 | 65.7 | 52 | 236.8 | 86.2 |
| 13 | 12.2 | 4.4 | 73 | 68.6 | 25.0 | 33 | 125.0 | 45.5 | 93 | 181.4 | 66.0 | 53 | 237.7 | 86.5 |
| 14 | 13.2 | 4.8 | 74 | 69.5 | 25.3 | 34 | 125.9 | 45.8 | 94 | 182.3 | 66.4 | 54 | 238.7 | 86.9 |
| 15 | 14.1 | 5.1 | 75 | 70.5 | 25.7 | 35 | 126.9 | 46.2 | 95 | 183.2 | 66.7 | 55 | 239.6 | 87.2 |
| 16 | 15.0 | 5.5 | 76 | 71.4 | 26.0 | 36 | 127.8 | 46.5 | 96 | 184.2 | 67.0 | 56 | 240.6 | 87.6 |
| 17 | 16.0 | 5.8 | 77 | 72.4 | 26.3 | 37 | 128.7 | 46.9 | 97 | 185.1 | 67.4 | 57 | 241.5 | 87.9 |
| 18 | 16.9 | 6.2 | 78 | 73.3 | 26.7 | 38 | 129.7 | 47.2 | 98 | 186.1 | 67.7 | 58 | 242.4 | 88.2 |
| 19 | 17.9 | 6.5 | 79 | 74.2 | 27.0 | 39 | 130.6 | 47.5 | 99 | 187.0 | 68.1 | 59 | 243.4 | 88.6 |
| 20 | 18.8 | 6.8 | 80 | 75.2 | 27.4 | 40 | 131.6 | 47.9 | 200 | 187.9 | 68.4 | 60 | 244.3 | 88.9 |
| 21 | 19.7 | 7.2 | 81 | 76.1 | 27.7 | 141 | 132.5 | 48.2 | 201 | 188.9 | 68.7 | 261 | 245.3 | 89.3 |
| 22 | 20.7 | 7.5 | 82 | 77.1 | 28.0 | 42 | 133.4 | 48.6 | 02 | 189.8 | 69.1 | 62 | 246.2 | 89.6 |
| 23 | 21.6 | 7.9 | 83 | 78.0 | 28.4 | 43 | 134.4 | 48.9 | 03 | 190.8 | 69.4 | 63 | 247.1 | 90.0 |
| 24 | 22.6 | 8.2 | 84 | 78.9 | 28.7 | 44 | 135.3 | 49.3 | 04 | 191.7 | 69.8 | 64 | 248.1 | 90.3 |
| 25 | 23.5 | 8.6 | 85 | 79.9 | 29.1 | 45 | 136.3 | 49.6 | 05 | 192.6 | 70.1 | 65 | 249.0 | 90.6 |
| 26 | 24.4 | 8.9 | 86 | 80.8 | 29.4 | 46 | 137.2 | 49.9 | 06 | 193.6 | 70.5 | 66 | 250.0 | 91.0 |
| 27 | 25.4 | 9.2 | 87 | 81.8 | 29.8 | 47 | 138.1 | 50.3 | 07 | 194.5 | 70.8 | 67 | 250.9 | 91.3 |
| 28 | 26.3 | 9.6 | 88 | 82.7 | 30.1 | 48 | 139.1 | 50.7 | 08 | 195.5 | 71.1 | 68 | 251.8 | 91.7 |
| 29 | 27.3 | 9.9 | 89 | 83.6 | 30.4 | 49 | 140.0 | 51.0 | 09 | 196.4 | 71.5 | 69 | 252.8 | 92.0 |
| 30 | 28.2 | 10.3 | 90 | 84.6 | 30.8 | 50 | 140.9 | 51.3 | 10 | 197.3 | 71.8 | 70 | 253.7 | 92.3 |
| 31 | 29.1 | 10.6 | 91 | 85.5 | 31.1 | 151 | 141.9 | 51.6 | 211 | 198.3 | 72.2 | 271 | 254.7 | 92.7 |
| 32 | 30.1 | 10.9 | 92 | 86.5 | 31.5 | 52 | 142.8 | 52.0 | 12 | 199.2 | 72.5 | 72 | 255.6 | 93.0 |
| 33 | 31.0 | 11.3 | 93 | 87.4 | 31.8 | 53 | 143.8 | 52.3 | 13 | 200.2 | 72.9 | 73 | 256.5 | 93.4 |
| 34 | 31.9 | 11.6 | 94 | 88.3 | 32.1 | 54 | 144.7 | 52.7 | 14 | 201.1 | 73.2 | 74 | 257.5 | 93.7 |
| 35 | 32.9 | 12.0 | 95 | 89.3 | 32.5 | 55 | 145.7 | 53.0 | 15 | 202.0 | 73.5 | 75 | 258.4 | 94.1 |
| 36 | 33.8 | 12.3 | 96 | 90.2 | 32.8 | 56 | 146.6 | 53.4 | 16 | 203.0 | 73.9 | 76 | 259.4 | 94.4 |
| 37 | 34.8 | 12.7 | 97 | 91.2 | 33.2 | 57 | 147.5 | 53.7 | 17 | 203.9 | 74.2 | 77 | 260.3 | 94.7 |
| 38 | 35.7 | 13.0 | 98 | 92.1 | 33.5 | 58 | 148.5 | 54.0 | 18 | 204.9 | 74.6 | 78 | 261.2 | 95.1 |
| 39 | 36.6 | 13.3 | 99 | 93.0 | 33.9 | 59 | 149.4 | 54.4 | 19 | 205.8 | 74.9 | 79 | 262.2 | 95.4 |
| 40 | 37.6 | 13.7 | 100 | 94.0 | 34.2 | 60 | 150.4 | 54.7 | 20 | 206.7 | 75.2 | 80 | 263.1 | 95.8 |
| 41 | 38.5 | 14.0 | 101 | 94.9 | 34.5 | 161 | 151.3 | 55.1 | 221 | 207.7 | 75.6 | 281 | 264.1 | 96.1 |
| 42 | 39.5 | 14.4 | 02 | 95.8 | 34.9 | 62 | 152.2 | 55.4 | 22 | 208.6 | 75.9 | 82 | 265.0 | 96.4 |
| 43 | 40.4 | 14.7 | 03 | 96.8 | 35.2 | 63 | 153.2 | 55.7 | 23 | 209.6 | 76.3 | 83 | 265.9 | 96.8 |
| 44 | 41.3 | 15.0 | 04 | 97.7 | 35.6 | 64 | 154.1 | 56.1 | 24 | 210.5 | 76.6 | 84 | 266.9 | 97.1 |
| 45 | 42.3 | 15.4 | 05 | 98.7 | 35.9 | 65 | 155.0 | 56.4 | 25 | 211.4 | 77.0 | 85 | 267.8 | 97.5 |
| 46 | 43.2 | 15.7 | 06 | 99.6 | 36.3 | 66 | 156.0 | 56.8 | 26 | 212.4 | 77.3 | 86 | 268.8 | 97.8 |
| 47 | 44.2 | 16.1 | 07 | 100.5 | 36.6 | 67 | 156.9 | 57.1 | 27 | 213.3 | 77.6 | 87 | 269.7 | 98.2 |
| 48 | 45.1 | 16.4 | 08 | 101.5 | 36.9 | 68 | 157.9 | 57.5 | 28 | 214.2 | 78.0 | 88 | 270.6 | 98.5 |
| 49 | 46.0 | 16.8 | 09 | 102.4 | 37.3 | 69 | 158.8 | 57.8 | 29 | 215.2 | 78.3 | 89 | 271.6 | 98.8 |
| 50 | 47.0 | 17.1 | 10 | 103.4 | 37.6 | 70 | 159.7 | 58.1 | 30 | 216.1 | 78.7 | 90 | 272.5 | 99.2 |
| 51 | 47.9 | 17.4 | 111 | 104.3 | 38.0 | 171 | 160.7 | 58.5 | 231 | 217.1 | 79.0 | 291 | 273.5 | 99.5 |
| 52 | 48.9 | 17.8 | 12 | 105.2 | 38.3 | 72 | 161.6 | 58.8 | 32 | 218.0 | 79.3 | 92 | 274.4 | 99.9 |
| 53 | 49.8 | 18.1 | 13 | 106.2 | 38.6 | 73 | 162.6 | 59.2 | 33 | 218.9 | 79.7 | 93 | 275.3 | 100.2 |
| 54 | 50.7 | 18.5 | 14 | 107.1 | 39.0 | 74 | 163.5 | 59.5 | 34 | 219.9 | 80.0 | 94 | 276.3 | 100.6 |
| 55 | 51.7 | 18.8 | 15 | 108.1 | 39.3 | 75 | 164.4 | 59.8 | 35 | 220.8 | 80.4 | 95 | 277.2 | 100.9 |
| 56 | 52.6 | 19.2 | 16 | 109.0 | 39.7 | 76 | 165.4 | 60.2 | 36 | 221.8 | 80.7 | 96 | 278.1 | 101.2 |
| 57 | 53.6 | 19.5 | 17 | 109.9 | 40.0 | 77 | 166.3 | 60.5 | 37 | 222.7 | 81.1 | 97 | 279.1 | 101.6 |
| 58 | 54.5 | 19.8 | 18 | 110.9 | 40.4 | 78 | 167.3 | 60.9 | 38 | 223.6 | 81.4 | 98 | 280.0 | 101.9 |
| 59 | 55.4 | 20.2 | 19 | 111.8 | 40.7 | 79 | 168.2 | 61.2 | 39 | 224.6 | 81.7 | 99 | 281.0 | 102.3 |
| 60 | 56.4 | 20.5 | 20 | 112.8 | 41.0 | 80 | 169.1 | 61.6 | 40 | 225.5 | 82.1 | 300 | 281.9 | 102.6 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

70° (110°, 250°, 290°).

TABLE 2. [Page 407

Difference of Latitude and Departure for 20° (160°, 200°, 340°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 282.9 | 103.0 | 361 | 339.2 | 123.5 | 421 | 395.6 | 144.0 | 481 | 452.0 | 164.5 | 541 | 508.4 | 185.0 |
| 02 | 283.8 | 103.3 | 62 | 340.2 | 123.8 | 22 | 396.6 | 144.3 | 82 | 453.0 | 164.8 | 42 | 509.3 | 185.4 |
| 03 | 284.7 | 103.6 | 63 | 341.1 | 124.2 | 23 | 397.5 | 144.7 | 83 | 453.9 | 165.2 | 43 | 510.3 | 185.7 |
| 04 | 285.7 | 104.0 | 64 | 342.1 | 124.5 | 24 | 398.4 | 145.0 | 84 | 454.8 | 165.5 | 44 | 511.2 | 186.0 |
| 05 | 286.6 | 104.3 | 65 | 343.0 | 124.8 | 25 | 399.4 | 145.4 | 85 | 455.8 | 165.9 | 45 | 512.1 | 186.4 |
| 06 | 287.6 | 104.7 | 66 | 343.9 | 125.2 | 26 | 400.3 | 145.7 | 86 | 456.7 | 166.3 | 46 | 513.1 | 186.8 |
| 07 | 288.5 | 105.0 | 67 | 344.9 | 125.5 | 27 | 401.3 | 146.1 | 87 | 457.7 | 166.6 | 47 | 514.0 | 187.1 |
| 08 | 289.4 | 105.4 | 68 | 345.8 | 125.9 | 28 | 402.2 | 146.4 | 88 | 458.6 | 166.9 | 48 | 515.0 | 187.4 |
| 09 | 290.4 | 105.7 | 69 | 346.8 | 126.2 | 29 | 403.1 | 146.7 | 89 | 459.5 | 167.3 | 49 | 515.9 | 187.8 |
| 10 | 291.3 | 106.0 | 70 | 347.7 | 126.6 | 30 | 404.1 | 147.1 | 90 | 460.5 | 167.7 | 50 | 516.8 | 188.2 |
| 311 | 292.3 | 106.4 | 371 | 348.6 | 126.9 | 431 | 405.0 | 147.4 | 491 | 461.4 | 168.0 | 551 | 517.8 | 188.5 |
| 12 | 293.2 | 106.7 | 72 | 349.6 | 127..2 | 32 | 406.0 | 147.8 | 92 | 462.4 | 168.3 | 52 | 518.7 | 188.8 |
| 13 | 294.1 | 107.1 | 73 | 350.5 | 127.6 | 33 | 406.9 | 148.1 | 93 | 463.3 | 168.6 | 53 | 519.7 | 189.1 |
| 14 | 295.1 | 107.4 | 74 | 351.5 | 127.9 | 34 | 407.8 | 148.4 | 94 | 464.2 | 168.9 | 54 | 520.6 | 189.4 |
| 15 | 296.0 | 107.7 | 75 | 352.4 | 128.3 | 35 | 408.8 | 148.8 | 95 | 465.2 | 169.3 | 55 | 521.5 | 189.8 |
| 16 | 297.0 | 108.1 | 76 | 353.3 | 128.6 | 36 | 409.7 | 149.1 | 96 | 466.1 | 169.6 | 56 | 522.5 | 190.2 |
| 17 | 297.9 | 108.4 | 77 | 354.3 | 129.0 | 37 | 410.7 | 149.5 | 97 | 467.0 | 170.0 | 57 | 523.4 | 190.5 |
| 18 | 298.8 | 108.8 | 78 | 355.2 | 129.3 | 38 | 411.6 | 149.8 | 98 | 468.0 | 170.3 | 58 | 524.4 | 190.8 |
| 19 | 299.8 | 109.1 | 79 | 356.2 | 129.6 | 39 | 412.5 | 150.2 | 99 | 468.9 | 170.7 | 59 | 525.3 | 191.2 |
| 20 | 300.7 | 109.5 | 80 | 357.1 | 130.0 | 40 | 413.5 | 150.5 | 500 | 469.9 | 171.0 | 60 | 526.2 | 191.6 |
| 321 | 301.6 | 109.8 | 381 | 358.0 | 130.3 | 441 | 414.4 | 150.8 | 501 | 470.8 | 171.3 | 561 | 527.2 | 191.9 |
| 22 | 302.6 | 110.1 | 82 | 359.0 | 130.7 | 42 | 415.4 | 151.2 | 02 | 471.7 | 171.7 | 62 | 528.1 | 192.2 |
| 23 | 303.5 | 110.5 | 83 | 359.9 | 131.0 | 43 | 416.3 | 151.5 | 03 | 472.7 | 172.0 | 63 | 529.0 | 192.5 |
| 24 | 304.5 | 110.8 | 84 | 360.8 | 131.3 | 44 | 417.2 | 151.9 | 04 | 473.6 | 172.4 | 64 | 530.0 | 192.9 |
| 25 | 305.4 | 111.2 | 85 | 361.8 | 131.7 | 45 | 418.2 | 152.2 | 05 | 474.5 | 172.7 | 65 | 530.9 | 193.2 |
| 26 | 306.3 | 111.5 | 86 | 362.7 | 132.0 | 46 | 419.1 | 152.5 | 06 | 475.4 | 173.0 | 66 | 531.8 | 193.6 |
| 27 | 307.3 | 111.8 | 87 | 363.7 | 132.4 | 47 | 420.0 | 152.9 | 07 | 476.4 | 173.4 | 67 | 532.8 | 193.9 |
| 28 | 308.2 | 112.2 | 88 | 364.6 | 132.7 | 48 | 421.0 | 153.2 | 08 | 477.3 | 173.7 | 68 | 533.7 | 194.2 |
| 29 | 309.2 | 112.5 | 89 | 365.5 | 133.1 | 49 | 421.9 | 153.6 | 09 | 478.3 | 174.1 | 69 | 534.7 | 194.6 |
| 30 | 310.1 | 112.9 | 90 | 366.5 | 133.4 | 50 | 422.9 | 153.9 | 10 | 479.2 | 174.4 | 70 | 535.6 | 195.0 |
| 331 | 311.0 | 113.2 | 391 | 367.4 | 133.7 | 451 | 423.8 | 154.3 | 511 | 480.2 | 174.8 | 571 | 536.6 | 195.3 |
| 32 | 312.0 | 113.6 | 92 | 368.4 | 134.1 | 52 | 424.7 | 154.6 | 12 | 481.1 | 175.1 | 72 | 537.5 | 195.6 |
| 33 | 312.9 | 113.9 | 93 | 369.3 | 134.4 | 53 | 425.7 | 154.9 | 13 | 482.1 | 175.4 | 73 | 538.5 | 195.9 |
| 34 | 313.9 | 114.2 | 94 | 370.2 | 134.8 | 54 | 426.6 | 155.3 | 14 | 483.0 | 175.8 | 74 | 539.4 | 196.3 |
| 35 | 314.8 | 114.6 | 95 | 371.2 | 135.1 | 55 | 427.6 | 155.6 | 15 | 484.0 | 176.1 | 75 | 540.3 | 196.6 |
| 36 | 315.7 | 114.9 | 96 | 372.1 | 135.4 | 56 | 428.5 | 156.0 | 16 | 484.9 | 176.5 | 76 | 541.3 | 197.0 |
| 37 | 316.7 | 115.3 | 97 | 373.1 | 135.8 | 57 | 429.4 | 156.3 | 17 | 485.8 | 176.8 | 77 | 542.2 | 197.3 |
| 38 | 317.6 | 115.6 | 98 | 374.0 | 136.1 | 58 | 430.4 | 156.7 | 18 | 486.8 | 177.2 | 78 | 543.2 | 197.7 |
| 39 | 318.6 | 116.0 | 99 | 374.9 | 136.5 | 59 | 431.3 | 157.0 | 19 | 487.7 | 177.5 | 79 | 544.1 | 198.0 |
| 40 | 319.5 | 116.3 | 400 | 375.9 | 136.8 | 60 | 432.3 | 157.4 | 20 | 488.7 | 177.9 | 80 | 545.0 | 198.4 |
| 341 | 320.4 | 116.6 | 401 | 376.8 | 137.2 | 461 | 433.2 | 157.7 | 521 | 489.6 | 178.2 | 581 | 546.0 | 198.7 |
| 42 | 321.4 | 117.0 | 02 | 377.8 | 137.5 | 62 | 434.1 | 158.0 | 22 | 490.5 | 178.5 | 82 | 546.9 | 199.0 |
| ·43 | 322.3 | 117.3 | 03 | 378.7 | 137.8 | 63 | 435.1 | 158.4 | 23 | 491.5 | 178.9 | 83 | 547.9 | 199.4 |
| 44 | 323.3 | 117.7 | 04 | 379.6 | 138.2 | 64 | 436.0 | 158.7 | 24 | 492.4 | 179.2 | 84 | 548.8 | 199.8 |
| 45 | 324.2 | 118.0 | 05 | 380.6 | 138.5 | 65 | 437.0 | 159.0 | 25 | 493.4 | 179.6 | 85 | 549.8 | 200.1 |
| 46 | 325.1 | 118.4 | 06 | 381.5 | 138.9 | 66 | 437.9 | 159.4 | 26 | 494.3 | 179.9 | 86 | 550.7 | 200.4 |
| 47 | 326.1 | 118.7 | 07 | 382.5 | 139.2 | 67 | 438.8 | 159.7 | 27 | 495.3 | 180.2 | 87 | 551.7 | 200.8 |
| 48 | 327.0 | 119.0 | 08 | 383.4 | 139.6 | 68 | 439.8 | 160.1 | 28 | 496.2 | 180.6 | 88 | 552.6 | 201.2 |
| 49 | 328.0 | 119.4 | 09 | 384.3 | 139.9 | 69 | 440.7 | 160.4 | 29 | 497.1 | 181.0 | 89 | 553.5 | 201.5 |
| 50 | 328.9 | 119.7 | 10 | 385.3 | 140.2 | 70 | 441.7 | 160.8 | 30 | 498.1 | 181.3 | 90 | 554.4 | 201.8 |
| 351 | 329.8 | 120.1 | 411 | 386.2 | 140.6 | 471 | 442.6 | 161.1 | 531 | 499.0 | 181.6 | 591 | 555.4 | 202.1 |
| 52 | 330.8 | 120.4 | 12 | 387.2 | 140.9 | 72 | 443.5 | 161.4 | 32 | 499.9 | 181.9 | 92 | 556.3 | 202.4 |
| 53 | 331.7 | 120.7 | 13 | 388.1 | 141.3 | 73 | 444.5 | 161.8 | 33 | 500.9 | 182.3 | 93 | 557.3 | 202.8 |
| 54 | 332.7 | 121.1 | 14 | 389.0 | 141.6 | 74 | 445.4 | 162.1 | 34 | 501.8 | 182.6 | 94 | 558.2 | 203.2 |
| 55 | 333.6 | 121.4 | 15 | 390.0 | 141.9 | 75 | 446.4 | 162.5 | 35 | 502.7 | 183.0 | 95 | 559.1 | 203.5 |
| 56 | 334.5 | 121.8 | 16 | 390.9 | 142.3 | 76 | 447.3 | 162.8 | 36 | 503.7 | 183.3 | 96 | 560.0 | 203.8 |
| 57 | 335.5 | 122.1 | 17 | 391.9 | 142.6 | 77 | 448.2 | 163.2 | 37 | 504.6 | 183.7 | 97 | 561.0 | 204.2 |
| 58 | 336.4 | 122.5· | 18 | 392.8 | 143.0 | 78 | 449.2 | 163.5 | 38 | 505.5 | 184.0 | 98 | 561.9 | 204.6 |
| 59 | 337.4 | 122.8 | 19 | 393.7 | 143.3 | 79 | 450.1 | 163.8 | 39 | 506.5 | 184.3 | 99 | 562.9 | 204.9 |
| 60 | 338.3 | 123.1 | 20 | 394.7 | 143.7 | 80 | 451.1 | 164.2 | 40 | 507.4 | 184.7 | 600 | 563.8 | 205.2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

70° (110°, 250°, 290°).

TABLE 2.

Difference of Latitude and Departure for 21° (159°, 201°, 339°).

| Dist | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 56.9 | 21.9 | 121 | 113.0 | 43.4 | 181 | 169.0 | 64.9 | 241 | 225.0 | 86.4 |
| 2 | 1.9 | 0.7 | 62 | 57.9 | 22.2 | 22 | 113.9 | 43.7 | 82 | 169.9 | 65.2 | 42 | 225.9 | 86.7 |
| 3 | 2.8 | 1.1 | 63 | 58.8 | 22.6 | 23 | 114.8 | 44.1 | 83 | 170.8 | 65.6 | 43 | 226.9 | 87.1 |
| 4 | 3.7 | 1.4 | 64 | 59.7 | 22.9 | 24 | 115.8 | 44.4 | 84 | 171.8 | 65.9 | 44 | 227.8 | 87.4 |
| 5 | 4.7 | 1.8 | 65 | 60.7 | 23.3 | 25 | 116.7 | 44.8 | 85 | 172.7 | 66.3 | 45 | 228.7 | 87.8 |
| 6 | 5.6 | 2.2 | 66 | 61.6 | 23.7 | 26 | 117.6 | 45.2 | 86 | 173.6 | 66.7 | 46 | 229.7 | 88.2 |
| 7 | 6.5 | 2.5 | 67 | 62.5 | 24.0 | 27 | 118.6 | 45.5 | 87 | 174.6 | 67.0 | 47 | 230.6 | 88.5 |
| 8 | 7.5 | 2.9 | 68 | 63.5 | 24.4 | 28 | 119.5 | 45.9 | 88 | 175.5 | 67.4 | 48 | 231.5 | 88.9 |
| 9 | 8.4 | 3.2 | 69 | 64.4 | 24.7 | 29 | 120.4 | 46.2 | 89 | 176.4 | 67.7 | 49 | 232.5 | 89.2 |
| 10 | 9.3 | 3.6 | 70 | 65.4 | 25.1 | 30 | 121.4 | 46.6 | 90 | 177.4 | 68.1 | 50 | 233.4 | 89.6 |
| 11 | 10.3 | 3.9 | 71 | 66.3 | 25.4 | 131 | 122.3 | 46.9 | 191 | 178.3 | 68.4 | 251 | 234.3 | 90.0 |
| 12 | 11.2 | 4.3 | 72 | 67.2 | 25.8 | 32 | 123.2 | 47.3 | 92 | 179.2 | 68.8 | 52 | 235.3 | 90.3 |
| 13 | 12.1 | 4.7 | 73 | 68.2 | 26.2 | 33 | 124.2 | 47.7 | 93 | 180.2 | 69.2 | 53 | 236.2 | 90.7 |
| 14 | 13.1 | 5.0 | 74 | 69.1 | 26.5 | 34 | 125.1 | 48.0 | 94 | 181.1 | 69.5 | 54 | 237.1 | 91.0 |
| 15 | 14.0 | 5.4 | 75 | 70.0 | 26.9 | 35 | 126.0 | 48.4 | 95 | 182.0 | 69.9 | 55 | 238.1 | 91.4 |
| 16 | 14.9 | 5.7 | 76 | 71.0 | 27.2 | 36 | 127.0 | 48.7 | 96 | 183.0 | 70.2 | 56 | 239.0 | 91.7 |
| 17 | 15.9 | 6.1 | 77 | 71.9 | 27.6 | 37 | 127.9 | 49.1 | 97 | 183.9 | 70.6 | 57 | 239.9 | 92.1 |
| 18 | 16.8 | 6.5 | 78 | 72.8 | 28.0 | 38 | 128.8 | 49.5 | 98 | 184.8 | 71.0 | 58 | 240.9 | 92.5 |
| 19 | 17.7 | 6.8 | 79 | 73.8 | 28.3 | 39 | 129.8 | 49.8 | 99 | 185.8 | 71.3 | 59 | 241.8 | 92.8 |
| 20 | 18.7 | 7.2 | 80 | 74.7 | 28.7 | 40 | 130.7 | 50.2 | 200 | 186.7 | 71.7 | 60 | 242.7 | 93.2 |
| 21 | 19.6 | 7.5 | 81 | 75.6 | 29.0 | 141 | 131.6 | 50.5 | 201 | 187.6 | 72.0 | 261 | 243.7 | 93.5 |
| 22 | 20.5 | 7.9 | 82 | 76.6 | 29.4 | 42 | 132.6 | 50.9 | 02 | 188.6 | 72.4 | 62 | 244.6 | 93.9 |
| 23 | 21.5 | 8.2 | 83 | 77.5 | 29.7 | 43 | 133.5 | 51.2 | 03 | 189.5 | 72.7 | 63 | 245.5 | 94.3 |
| 24 | 22.4 | 8.6 | 84 | 78.4 | 30.1 | 44 | 134.4 | 51.6 | 04 | 190.5 | 73.1 | 64 | 246.5 | 94.6 |
| 25 | 23.3 | 9.0 | 85 | 79.4 | 30.5 | 45 | 135.4 | 52.0 | .05 | 191.4 | 73.5 | 65 | 247.4 | 95.0 |
| 26 | 24.3 | 9.3 | 86 | 80.3 | 30.8 | 46 | 136.3 | 52.3 | 06 | 192.3 | 73.8 | 66 | 248.3 | 95.3 |
| 27 | 25.2 | 9.7 | 87 | 81.2 | 31.2 | 47 | 137.2 | 52.7 | 07 | 193.3 | 74.2 | 67 | 249.3 | 95.7 |
| 28 | 26.1 | 10.0 | 88 | 82.2 | 31.5 | 48 | 138.2 | 53.0 | 08 | 194.2 | 74.5 | 68 | 250.2 | 96.0 |
| 29 | 27.1 | 10.4 | 89 | 83.1 | 31.9 | 49 | 139.1 | 53.4 | 09 | 195.1 | 74.9 | 69 | 251.1 | 96.4 |
| 30 | 28.0 | 10.8 | 90 | 84.0 | 32.3 | 50 | 140.0 | 53.8 | 10 | 196.1 | 75.3 | 70 | 252.1 | 96.8 |
| 31 | 28.9 | 11.1 | 91 | 85.0 | 32.6 | 151 | 141.0 | 54.1 | 211 | 197.0 | 75.6 | 271 | 253.0 | 97.1 |
| 32 | 29.9 | 11.5 | 92 | 85.9 | 33.0 | 52 | 141.9 | 54.5 | 12 | 197.9 | 76.0 | 72 | 253.9 | 97.5 |
| 33 | 30.8 | 11.8 | 93 | 86.8 | 33.3 | 53 | 142.8 | 54.8 | 13 | 198.9 | 76.3 | 73 | 254.9 | 97.8 |
| 34 | 31.7 | 12.2 | 94 | 87.8 | 33.7 | 54 | 143.8 | 55.2 | 14 | 199.8 | 76.7 | 74 | 255.8 | 98.2 |
| 35 | 32.7 | 12.5 | 95 | 88.7 | 34.0 | 55 | 144.7 | 55.5 | 15 | 200.7 | 77.0 | 75 | 256.7 | 98.6 |
| 36 | 33.6 | 12.9 | 96 | 89.6 | 34.4 | 56 | 145.6 | 55.9 | 16 | 201.7 | 77.4 | 76 | 257.7 | 98.9 |
| 37 | 34.5 | 13.3 | 97 | 90.6 | 34.8 | 57 | 146.6 | 56.3 | 17 | 202.6 | 77.8 | 77 | 258.6 | 99.3 |
| 38 | 35.5 | 13.6 | 98 | 91.5 | 35.1 | 58 | 147.5 | 56.6 | 18 | 203.5 | 78.1 | 78 | 259.5 | 99.6 |
| 39 | 36.4 | 14.0 | 99 | 92.4 | 35.5 | 59 | 148.4 | 57.0 | 19 | 204.5 | 78.5 | 79 | 260.5 | 100.0 |
| 40 | 37.3 | 14.3 | 100 | 93.4 | 35.8 | 60 | 149.4 | 57.3 | 20 | 205.4 | 78.8 | 80 | 261.4 | 100.3 |
| 41 | 38.3 | 14.7 | 101 | 94.3 | 36.2 | 161 | 150.3 | 57.7 | 221 | 206.3 | 79.2 | 281 | 262.3 | 100.7 |
| 42 | 39.2 | 15.1 | 02 | 95.2 | 36.6 | 62 | 151.2 | 58.1 | 22 | 207.3 | 79.6 | 82 | 263.3 | 101.1 |
| 43 | 40.1 | 15.4 | 03 | 96.2 | 36.9 | 63 | 152.2 | 58.4 | 23 | 208.2 | 79.9 | 83 | 264.2 | 101.4 |
| 44 | 41.1 | 15.8 | 04 | 97.1 | 37.3 | 64 | 153.1 | 58.8 | 24 | 209.1 | 80.3 | 84 | 265.1 | 101.8 |
| 45 | 42.0 | 16.1 | 05 | 98.0 | 37.6 | 65 | 154.0 | 59.1 | 25 | 210.1 | 80.6 | 85 | 266.1 | 102.1 |
| 46 | 42.9 | 16.5 | 06 | 99.0 | 38.0 | 66 | 155.0 | 59.5 | 26 | 211.0 | 81.0 | 86 | 267.0 | 102.5 |
| 47 | 43.9 | 16.8 | 07 | 99.9 | 38.3 | 67 | 155.9 | 59.8 | 27 | 211.9 | 81.3 | 87 | 267.9 | 102.9 |
| 48 | 44.8 | 17.2 | 08 | 100.8 | 38.7 | 68 | 156.8 | 60.2 | 28 | 212.9 | 81.7 | 88 | 268.9 | 103.2 |
| 49 | 45.7 | 17.6 | 09 | 101.8 | 39.1 | 69 | 157.8 | 60.6 | 29 | 213.8 | 82.1 | 89 | 269.8 | 103.6 |
| 50 | 46.7 | 17.9 | 10 | 102.7 | 39.4 | 70 | 158.7 | 60.9 | 30 | 214.7 | 82.4 | 90 | 270.7 | 103.9 |
| 51 | 47.6 | 18.3 | 111 | 103.6 | 39.8 | 171 | 159.6 | 61.3 | 231 | 215.7 | 82.8 | 291 | 271.7 | 104.3 |
| 52 | 48.5 | 18.6 | 12 | 104.6 | 40.1 | 72 | 160.6 | 61.6 | 32 | 216.6 | 83.1 | 92 | 272.6 | 104.6 |
| 53 | 49.5 | 19.0 | 13 | 105.5 | 40.5 | 73 | 161.5 | 62.0 | 33 | 217.5 | 83.5 | 93 | 273.5 | 105.0 |
| 54 | 50.4 | 19.4 | 14 | 106.4 | 40.9 | 74 | 162.4 | 62.4 | 34 | 218.5 | 83.9 | 94 | 274.5 | 105.4 |
| 55 | 51.3 | 19.7 | 15 | 107.4 | 41.2 | 75 | 163.4 | 62.7 | 35 | 219.4 | 84.2 | 95 | 275.4 | 105.7 |
| 56 | 52.3 | 20.1 | 16 | 108.3 | 41.6 | 76 | 164.3 | 63.1 | 36 | 220.3 | 84.6 | 96 | 276.3 | 106.1 |
| 57 | 53.2 | 20.4 | 17 | 109.2 | 41.9 | 77 | 165.2 | 63.4 | 37 | 221.3 | 84.9 | 97 | 277.3 | 106.4 |
| 58 | 54.1 | 20.8 | 18 | 110.2 | 42.3 | 78 | 166.2 | 63.8 | 38 | 222.2 | 85.3 | 98 | 278.2 | 106.8 |
| 59 | 55.1 | 21.1 | 19 | 111.1 | 42.6 | 79 | 167.1 | 64.1 | 39 | 233.1 | 85.6 | 99 | 279.1 | 107.2 |
| 60 | 56.0 | 21.5 | 20 | 112.0 | 43.0 | 80 | 168.0 | 64.5 | 40 | 224.1 | 86.0 | 300 | 280.1 | 107.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

69° (111°, 249°, 291°).

TABLE 2. [Page 409

Difference of Latitude and Departure for 21° (159°, 201°, 339°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 281.0 | 107.9 | 361 | 337.0 | 129.4 | 421 | 393.0 | 150.9 | 481 | 449.0 | 172.4 | 541 | 505.1 | 193.9 |
| 02 | 281.9 | 108.2 | 62 | 337.9 | 129.7 | 22 | 394.0 | 151.2 | 82 | 450.0 | 172.7 | 42 | 506.0 | 194.2 |
| 03 | 282.9 | 108.6 | 63 | 338.9 | 130.1 | 23 | 394.9 | 151.6 | 83 | 450.9 | 173.1 | 43 | 507.0 | 194.6 |
| 04 | 283.8 | 108.9 | 64 | 339.8 | 130.4 | 24 | 395.8 | 152.0 | 84 | 451.8 | 173.5 | 44 | 507.9 | 195.0 |
| 05 | 284.7 | 109.3 | 65 | 340.7 | 130.8 | 25 | 396.8 | 152.3 | 85 | 452.8 | 173.8 | 45 | 508.8 | 195.3 |
| 06 | 285.7 | 109.7 | 66 | 341.7 | 131.2 | 26 | 397.7 | 152.7 | 86 | 453.7 | 174.2 | 46 | 509.8 | 195.7 |
| 07 | 286.6 | 110.0 | 67 | 342.6 | 131.5 | 27 | 398.6 | 153.0 | 87 | 454.6 | 174.5 | 47 | 510.7 | 196.0 |
| 08 | 287.5 | 110.4 | 68 | 343.5 | 131.9 | 28 | 399.6 | 153.4 | 88 | 455.6 | 174.9 | 48 | 511.6 | 196.4 |
| 09 | 288.5 | 110.7 | 79 | 344.5 | 132.2 | 29 | 400.5 | 153.7 | 89 | 456.5 | 175.2 | 49 | 512.6 | 196.8 |
| 10 | 289.4 | 111.1 | 70 | 345.4 | 132.6 | 30 | 401.4 | 154.1 | 90 | 457.4 | 175.6 | 50 | 513.5 | 197.1 |
| 311 | 290.3 | 111.5 | 371 | 346.3 | 133.0 | 431 | 402.4 | 154.5 | 491 | 458.4 | 176.0 | 551 | 514.4 | 197.5 |
| 12 | 291.3 | 111.8 | 72 | 347.3 | 133.3 | 32 | 403.3 | 154.8 | 92 | 459.3 | 176.3 | 52 | 515.4 | 197.8 |
| 13 | 292.2 | 112.2 | 73 | 348.2 | 133.7 | 33 | 404.2 | 155.2 | 93 | 460.2 | 176.7 | 53 | 516.3 | 198.2 |
| 14 | 293.1 | 112.5 | 74 | 349.1 | 134.0 | 34 | 405.2 | 155.5 | 94 | 461.2 | 177.0 | 54 | 517.2 | 198.6 |
| 15 | 294.1 | 112.9 | 75 | 350.1 | 134.4 | 35 | 406.1 | 155.9 | 95 | 462.1 | 177.4 | 55 | 518.2 | 198.9 |
| 16 | 295.0 | 113.2 | 76 | 351.0 | 134.7 | 36 | 407.0 | 156.3 | 96 | 463.0 | 177.8 | 56 | 519.1 | 199.3 |
| 17 | 295.9 | 113.6 | 77 | 351.9 | 135.1 | 37 | 408.0 | 156.6 | 97 | 464.0 | 178.1 | 57 | 520.0 | 199.6 |
| 18 | 296.9 | 114.0 | 78 | 352.9 | 135.5 | 38 | 408.9 | 157.0 | 98 | 464.9 | 178.5 | 58 | 521.0 | 200.0 |
| 19 | 297.8 | 114.3 | 79 | 353.8 | 135.8 | 39 | 409.8 | 157.3 | 99 | 465.8 | 178.8 | 59 | 521.9 | 200.3 |
| 20 | 298.7 | 114.7 | 80 | 354.7 | 136.2 | 40 | 410.8 | 157.7 | 500 | 466.8 | 179.2 | 60 | 522.8 | 200.7 |
| 321 | 299.7 | 115.0 | 381 | 355.7 | 136.5 | 441 | 411.7 | 158.0 | 501 | 467.7 | 179.5 | 561 | 523.8 | 201.0 |
| 22 | 300.6 | 115.4 | 82 | 356.6 | 136.9 | 42 | 412.6 | 158.4 | 02 | 468.6 | 179.9 | 62 | 524.7 | 201.4 |
| 23 | 301.5 | 115.8 | 83 | 357.5 | 137.3 | 43 | 413.6 | 158.8 | 03 | 469.6 | 180.3 | 63 | 525.6 | 201.8 |
| 24 | 302.5 | 116.1 | 84 | 358.5 | 137.6 | 44 | 414.5 | 159.1 | 04 | 470.5 | 180.6 | 64 | 526.6 | 202.1 |
| 25 | 303.4 | 116.5 | 85 | 359.4 | 138.0 | 45 | 415.4 | 159.5 | 05 | 471.5 | 181.0 | 65 | 527.5 | 202.5 |
| 26 | 304.3 | 116.8 | 86 | 360.3 | 138.3 | 46 | 416.4 | 159.8 | 06 | 472.4 | 181.3 | 66 | 528.4 | 202.8 |
| 27 | 305.3 | 117.2 | 87 | 361.3 | 138.7 | 47 | 417.3 | 160.2 | 07 | 473.3 | 181.7 | 67 | 529.4 | 203.2 |
| 28 | 306.2 | 117.5 | 88 | 362.2 | 139.1 | 48 | 418.2 | 160.5 | 08 | 474.3 | 182.0 | 68 | 530.3 | 203.5 |
| 29 | 307.1 | 117.9 | 89 | 363.1 | 139.4 | 49 | 419.2 | 160.9 | 09 | 475.2 | 182.4 | 69 | 531.2 | 203.9 |
| 30 | 308.1 | 118.3 | 90 | 364.1 | 139.8 | 50 | 420.1 | 161.3 | 10 | 476.1 | 182.8 | 70 | 532.2 | 204.3 |
| 331 | 309.0 | 118.6 | 391 | 365.0 | 140.1 | 451 | 421.0 | 161.6 | 511 | 477.1 | 183.1 | 571 | 533.1 | 204.6 |
| 32 | 309.9 | 119.0 | 92 | 365.9 | 140.5 | 52 | 422.0 | 162.0 | 12 | 478.0 | 183.5 | 72 | 534.0 | 205.0 |
| 33 | 310.9 | 119.3 | 93 | 366.9 | 140.8 | 53 | 422.9 | 162.3 | 13 | 478.9 | 183.8 | 73 | 535.0 | 205.4 |
| 34 | 311.8 | 119.7 | 94 | 367.8 | 141.2 | 54 | 423.8 | 162.7 | 14 | 479.9 | 184.2 | 74 | 535.9 | 205.7 |
| 35 | 312.7 | 120.1 | 95 | 368.7 | 141.6 | 55 | 424.8 | 163.1 | 15 | 480.8 | 184.6 | 75 | 536.8 | 206.1 |
| 36 | 313.7 | 120.4 | 96 | 369.7 | 141.9 | 56 | 425.7 | 163.4 | 16 | 481.7 | 184.9 | 76 | 537.8 | 206.4 |
| 37 | 314.6 | 120.8 | 97 | 370.6 | 142.3 | 57 | 426.6 | 163.8 | 17 | 482.7 | 185.3 | 77 | 538.7 | 206.8 |
| 38 | 315.5 | 121.1 | 98 | 371.5 | 142.6 | 58 | 427.6 | 164.1 | 18 | 483.6 | 185.6 | 78 | 539.6 | 207.1 |
| 39 | 316.5 | 121.5 | 99 | 372.5 | 143.0 | 59 | 428.5 | 164.5 | 19 | 484.5 | 186.0 | 79 | 540.6 | 207.5 |
| 40 | 317.4 | 121.8 | 400 | 373.4 | 143.4 | 60 | 429.4 | 164.9 | 20 | 485.5 | 186.4 | 80 | 541.5 | 207.9 |
| 341 | 318.3 | 122.2 | 401 | 374.3 | 143.7 | 461 | 430.4 | 165.2 | 521 | 486.4 | 186.7 | 581 | 542.4 | 208.2 |
| 42 | 319.3 | 122.6 | 02 | 375.3 | 144.1 | 62 | 431.3 | 165.6 | 22 | 487.3 | 187.1 | 82 | 543.4 | 208.6 |
| 43 | 320.2 | 122.9 | 03 | 376.2 | 144.4 | 63 | 432.2 | 165.9 | 23 | 488.3 | 187.4 | ﾮ83 | 544.3 | 208.9 |
| 44 | 321.1 | 123.2 | 04 | 377.1 | 144.8 | 64 | 433.2 | 166.3 | 24 | 489.2 | 187.8 | 84 | 545.2 | 209.3 |
| 45 | 322.1 | 123.6 | 05 | 378.1 | 145.1 | 65 | 434.1 | 166.6 | 25 | 490.1 | 188.1 | 85 | 546.2 | 209.6 |
| 46 | 323.0 | 124.0 | 06 | 379.0 | 145.5 | 66 | 435.0 | 167.0 | 26 | 491.1 | 188.5 | 86 | 547.1 | 210.0 |
| 47 | 323.9 | 124.4 | 07 | 379.9 | 145.9 | 67 | 436.0 | 167.4 | 27 | 492.0 | 188.9 | 87 | 548.0 | 210.4 |
| 48 | 324.9 | 124.7 | 08 | 380.9 | 146.2 | 68 | 436.9 | 167.7 | 28 | 492.9 | 189.2 | 88 | 549.0 | 210.7 |
| 49 | 325.8 | 125.1 | 09 | 381.8 | 146.6 | 69 | 437.8 | 168.1 | 29 | 493.9 | 189.6 | 89 | 549.9 | 211.1 |
| 50 | 326.7 | 125.4 | 10 | 382.7 | 146.9 | 70 | 438.8 | 168.4 | 30 | 494.8 | 189.9 | 90 | 550.8 | 211.4 |
| 351 | 327.7 | 125.8 | 411 | 383.7 | 147.3 | 471 | 439.7 | 168.8 | 531 | 495.7 | 190.3 | 591 | 551.8 | 211.8 |
| 52 | 328.6 | 126.1 | 12 | 384.6 | 147.7 | 72 | 440.6 | 169.2 | 32 | 496.7 | 190.7 | 92 | 552.7 | 212.2 |
| 53 | 329.5 | 126.5 | 13 | 385.5 | 148.0 | 73 | 441.6 | 169.5 | 33 | 497.6 | 191.0 | 93 | 553.6 | 212.5 |
| 54 | 330.5 | 126.9 | 14 | 386.5 | 148.4 | 74 | 442.5 | 169.9 | 34 | 498.5 | 191.4 | 94 | 554.6 | 212.9 |
| 55 | 331.4 | 127.2 | 15 | 387.4 | 148.7 | 75 | 443.4 | 170.2 | 35 | 499.5 | 191.7 | 95 | 555.5 | 213.2 |
| 56 | 332.3 | 127.6 | 16 | 388.4 | 149.1 | 76 | 444.4 | 170.6 | 36 | 500.4 | 192.1 | 96 | 556.4 | 213.6 |
| 57 | 333.3 | 127.9 | 17 | 389.3 | 149.4 | 77 | 445.3 | 170.9 | 37 | 501.3 | 192.4 | 97 | 557.4 | 213.9 |
| 58 | 334.2 | 128.3 | 18 | 390.2 | 149.8 | 78 | 446.2 | 171.3 | 38 | 502.3 | 192.8 | 98 | 558.2 | 214.3 |
| 59 | 335.1 | 128.7 | 19 | 391.2 | 150.2 | 79 | 447.2 | 171.7 | 39 | 503.2 | 193.2 | 99 | 559.2 | 214.7 |
| 60 | 336.1 | 129.0 | 20 | 392.1 | 150.5 | 80 | 448.1 | 172.0 | 40 | 504.1 | 193.5 | 600 | 560.1 | 215.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

69° (111°, 249°, 291°).

# TABLE 2.

Difference of Latitude and Departure for 22° (158°, 202, 338°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 56.6 | 22.9 | 121 | 112.2 | 45.3 | 181 | 167.8 | 67.8 | 241 | 223.5 | 90.3 |
| 2 | 1.9 | 0.7 | 62 | 57.5 | 23.2 | 22 | 113.1 | 45.7 | 82 | 168.7 | 68.2 | 42 | 224.4 | 90.7 |
| 3 | 2.8 | 1.1 | 63 | 58.4 | 23.6 | 23 | 114.0 | 46.1 | 83 | 169.7 | 68.6 | 43 | 225.3 | 91.0 |
| 4 | 3.7 | 1.5 | 64 | 59.3 | 24.0 | 24 | 115.0 | 46.5 | 84 | 170.6 | 68.9 | 44 | 226.2 | 91.4 |
| 5 | 4.6 | 1.9 | 65 | 60.3 | 24.3 | 25 | 115.9 | 46.8 | 85 | 171.5 | 69.3 | 45 | 227.2 | 91.8 |
| 6 | 5.6 | 2.2 | 66 | 61.2 | 24.7 | 26 | 116.8 | 47.2 | 86 | 172.5 | 69.7 | 46 | 228.1 | 92.2 |
| 7 | 6.5 | 2.6 | 67 | 62.1 | 25.1 | 27 | 117.8 | 47.6 | 87 | 173.4 | 70.1 | 47 | 229.0 | 92.5 |
| 8 | 7.4 | 3.0 | 68 | 63.0 | 25.5 | 28 | 118.7 | 47.9 | 88 | 174.3 | 70.4 | 48 | 229.9 | 92.9 |
| 9 | 8.3 | 3.4 | 69 | 64.0 | 25.8 | 29 | 119.6 | 48.3 | 89 | 175.2 | 70.8 | 49 | 230.9 | 93.3 |
| 10 | 9.3 | 3.7 | 70 | 64.9 | 26.2 | 30 | 120.5 | 48.7 | 90 | 176.2 | 71.2 | 50 | 231.8 | 93.7 |
| 11 | 10.2 | 4.1 | 71 | 65.8 | 26.6 | 131 | 121.5 | 49.1 | 191 | 177.1 | 71.5 | 251 | 232.7 | 94.0 |
| 12 | 11.1 | 4.5 | 72 | 66.8 | 27.0 | 32 | 122.4 | 49.4 | 92 | 178.0 | 71.9 | 52 | 233.7 | 94.4 |
| 13 | 12.1 | 4.9 | 73 | 67.7 | 27.3 | 33 | 123.3 | 49.8 | 93 | 178.9 | 72.3 | 53 | 234.6 | 94.8 |
| 14 | 13.0 | 5.2 | 74 | 68.6 | 27.7 | 34 | 124.2 | 50.2 | 94 | 179.9 | 72.7 | 54 | 235.5 | 95.2 |
| 15 | 13.9 | 5.6 | 75 | 69.5 | 28.1 | 35 | 125.2 | 50.6 | 95 | 180.8 | 73.0 | 55 | 236.4 | 95.5 |
| 16 | 14.8 | 6.0 | 76 | 70.5 | 28.5 | 36 | 126.1 | 50.9 | 96 | 181.7 | 73.4 | 56 | 237.4 | 95.9 |
| 17 | 15.8 | 6.4 | 77 | 71.4 | 28.8 | 37 | 127.0 | 51.3 | 97 | 182.7 | 73.8 | 57 | 238.3 | 96.3 |
| 18 | 16.7 | 6.7 | 78 | 72.3 | 29.2 | 38 | 128.0 | 51.7 | 98 | 183.6 | 74.2 | 58 | 239.2 | 96.6 |
| 19 | 17.6 | 7.1 | 79 | 73.2 | 29.6 | 39 | 128.9 | 52.1 | 99 | 184.5 | 74.5 | 59 | 240.1 | 97.0 |
| 20 | 18.5 | 7.5 | 80 | 74.2 | 30.0 | 40 | 129.8 | 52.4 | 200 | 185.4 | 74.9 | 60 | 241.1 | 97.4 |
| 21 | 19.5 | 7.9 | 81 | 75.1 | 30.3 | 141 | 130.7 | 52.8 | 201 | 186.4 | 75.3 | 261 | 242.0 | 97.8 |
| 22 | 20.4 | 8.2 | 82 | 76.0 | 30.7 | 42 | 131.7 | 53.2 | 02 | 187.3 | 75.7 | 62 | 242.9 | 98.1 |
| 23 | 21.3 | 8.6 | 83 | 77.0 | 31.1 | 43 | 132.6 | 53.6 | 03 | 188.2 | 76.0 | 63 | 243.8 | 98.5 |
| 24 | 22.3 | 9.0 | .84 | 77.9 | 31.5 | 44 | 133.5 | 53.9 | 04 | 189.1 | 76.4 | 64 | 244.8 | 98.9 |
| 25 | 23.2 | 9.4 | 85 | 78.8 | 31.8 | 45 | 134.4 | 54.3 | 05 | 190.1 | 76.8 | 65 | 245.7 | 99.3 |
| 26 | 24.1 | 9.7 | 86 | 79.7 | 32.2 | 46 | 135.4 | 54.7 | 06 | 191.0 | 77.2 | 66 | 246.6 | 99.6 |
| 27 | 25.0 | 10.1 | 87 | 80.7 | 32.6 | 47 | 136.3 | 55.1 | 07 | 191.9 | 77.5 | 67 | 247.6 | 100.0 |
| 28 | 26.0 | 10.5 | 88 | 81.6 | 33.0 | 48 | 137.2 | 55.4 | 08 | 192.9 | 77.9 | 68 | 248.5 | 100.4 |
| 29 | 26.9 | 10.9 | 89 | 82.5 | 33.3 | 49 | 138.2 | 55.8 | 09 | 193.8 | 78.3 | 69 | 249.4 | 100.8 |
| 30 | 27.8 | 11.2 | 90 | 83.4 | 33.7 | 50 | 139.1 | 56.2 | 10 | 194.7 | 78.7 | 70 | 250.3 | 101.1 |
| 31 | 28.7 | 11.6 | 91 | 84.4 | 34.1 | 151 | 140.0 | 56.6 | 211 | 195.6 | 79.0 | 271 | 251.3 | 101.5 |
| 32 | 29.7 | 12.0 | 92 | 85.3 | 34.5 | 52 | 140.9 | 56.9 | 12 | 196.6 | 79.4 | 72 | 252.2 | 101.9 |
| 33 | 30.6 | 12.4 | 93 | 86.2 | 34.8 | 53 | 141.9 | 57.3 | 13 | 197.5 | 79.8 | 73 | 253.1 | 102.3 |
| 34 | 31.5 | 12.7 | 94 | 87.2 | 35.2 | 54 | 142.8 | 57.7 | 14 | 198.4 | 80.2 | 74 | 254.0 | 102.6 |
| 35 | 32.5 | 13.1 | 95 | 88.1 | 35.6 | 55 | 143.7 | 58.1 | 15 | 199.3 | 80.5 | 75 | 255.0 | 103.0 |
| 36 | 33.4 | 13.5 | 96 | 89.0 | 36.0 | 56 | 144.6 | 58.4 | 16 | 200.3 | 80.9 | 76 | 255.9 | 103.4 |
| 37 | 34.3 | 13.9 | 97 | 89.9 | 36.3 | 57 | 145.6 | 58.8 | 17 | 201.2 | 81.3 | 77 | 256.8 | 103.8 |
| 38 | 35.2 | 14.2 | 98 | 90.9 | 36.7 | 58 | 146.5 | 59.2 | 18 | 202.1 | 81.7 | 78 | 257.8 | 104.1 |
| 39 | 36.2 | 14.6 | 99 | 91.8 | 37.1 | 59 | 147.4 | 59.6 | 19 | 203.1 | 82.0 | 79 | 258.7 | 104.5 |
| 40 | 37.1 | 15.0 | 100 | 92.7 | 37.5 | 60 | 148.3 | 59.9 | 20 | 204.0 | 82.4 | 80 | 259.6 | 104.9 |
| 41 | 38.0 | 15.4 | 101 | 93.6 | 37.8 | 161 | 149.3 | 60.3 | 221 | 204.9 | 82.8 | 281 | 260.5 | 105.3 |
| 42 | 38.9 | 15.7 | 02 | 94.6 | 38.2 | 62 | 150.2 | 60.7 | 22 | 205.8 | 83.2 | 82 | 261.5 | 105.6 |
| 43 | 39.9 | 16.1 | 03 | 95.5 | 38.6 | 63 | 151.1 | 61.1 | 23 | 206.8 | 83.5 | 83 | 262.4 | 106.0 |
| 44 | 40.8 | 16.5 | 04 | 96.4 | 39.0 | 64 | 152.1 | 61.4 | 24 | 207.7 | 83.9 | 84 | 263.3 | 106.4 |
| 45 | 41.7 | 16.9 | 05 | 97.4 | 39.3 | 65 | 153.0 | 61.8 | 25 | 208.6 | 84.3 | 85 | 264.2 | 106.8 |
| 46 | 42.7 | 17.2 | 06 | 98.3 | 39.7 | 66 | 153.9 | 62.2 | 26 | 209.5 | 84.7 | 86 | 265.2 | 107.1 |
| 47 | 43.6 | 17.6 | 07 | 99.2 | 40.1 | 67 | 154.8 | 62.6 | 27 | 210.5 | 85.0 | 87 | 266.1 | 107.5 |
| 48 | 44.5 | 18.0 | 08 | 100.1 | 40.5 | 68 | 155.8 | 62.9 | 28 | 211.4 | 85.4 | 88 | 267.0 | 107.9 |
| 49 | 45.4 | 18.4 | 09 | 101.1 | 40.8 | 69 | 156.7 | 63.3 | 29 | 212.3 | 85.8 | 89 | 268.0 | 108.3 |
| 50 | 46.4 | 18.7 | 10 | 102.0 | 41.2 | 70 | 157.6 | 63.7 | 30 | 213.3 | 86.2 | 90 | 268.9 | 108.6 |
| 51 | 47.3 | 19.1 | 111 | 102.9 | 41.6 | 171 | 158.5 | 64.1 | 231 | 214.2 | 86.5 | 291 | 269.8 | 109.0 |
| 52 | 48.2 | 19.5 | 12 | 103.8 | 42.0 | 72 | 159.5 | 64.4 | 32 | 215.1 | 86.9 | 92 | 270.7 | 109.4 |
| 53 | 49.1 | 19.9 | 13 | 104.8 | 42.3 | 73 | 160.4 | 64.8 | 33 | 216.0 | 87.3 | 93 | 271.7 | 109.8 |
| 54 | 50.1 | 20.2 | 14 | 105.7 | 42.7 | 74 | 161.3 | 65.2 | 34 | 217.0 | 87.7 | 94 | 272.6 | 110.1 |
| 55 | 51.0 | 20.6 | 15 | 106.6 | 43.1 | 75 | 162.3 | 65.6 | 35 | 217.9 | 88.0 | 95 | 273.5 | 110.5 |
| 56 | 51.9 | 21.0 | .16 | 107.6 | 43.5 | 76 | 163.2 | 65.9 | 36 | 218.8 | 88.4 | 96 | 274.4 | 110.9 |
| 57 | 52.8 | 21.4 | 17 | 108.5 | 43.8 | 77 | 164.1 | 66.3 | 37 | 219.7 | 88.8 | 97 | 275.4 | 111.3 |
| 58 | 53.8 | 21.7 | 18 | 109.4 | 44.2 | 78 | 165.0 | 66.7 | 38 | 220.7 | 89.2 | 98 | 276.3 | 111.6 |
| 59 | 54.7 | 22.1 | 19 | 110.3 | 44.6 | 79 | 166.0 | 67.1 | 39 | 221.6 | 89.5 | 99 | 277.2 | 112.0 |
| 60 | 55.6 | 22.5 | 20 | 111.3 | 45.0 | 80 | 166.9 | 67.4 | 40 | 222.5 | 89.9 | 300 | 278.2 | 112.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

68° (112°, 248°, 292°).

TABLE 2. [Page 411

Difference of Latitude and Departure for 22° (158°, 202°, 338°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 279.1 | 112.7 | 361 | 334.7 | 135.2 | 421 | 390.3 | 157.7 | 481 | 446.0 | 180.2 | 541 | 501.6 | 202.7 |
| 02 | 280.0 | 113.1 | 62 | 335.6 | 135.6 | 22 | 391.3 | 158.1 | 82 | 446.9 | 180.6 | 42 | 502.5 | 203.1 |
| 03 | 280.9 | 113.5 | 63 | 336.6 | 136.0 | 23 | 392.2 | 158.4 | 83 | 447.8 | 180.9 | 43 | 503.4 | 203.5 |
| 04 | 281.9 | 113.9 | 64 | 337.5 | 136.3 | 24 | 393.1 | 158.8 | 84 | 448.8 | 181.3 | 44 | 504.4 | 203.8 |
| 05 | 282.8 | 114.2 | 65 | 338.4 | 136.7 | 25 | 394.1 | 159.2 | 85 | 449.7 | 181.7 | 45 | 505.3 | 204.2 |
| 06 | 283.7 | 114.6 | 66 | 339.3 | 137.1 | 26 | 395.0 | 159.6 | 86 | 450.6 | 182.1 | 46 | 506.2 | 204.6 |
| 07 | 284.6 | 115.0 | 67 | 340.3 | 137.5 | 27 | 395.9 | 159.9 | 87 | 451.6 | 182.4 | 47 | 507.2 | 205.0 |
| 08 | 285.6 | 115.4 | 68 | 341.2 | 137.8 | 28 | 396.8 | 160.3 | 88 | 452.5 | 182.8 | 48 | 508.1 | 205.3 |
| 09 | 286.5 | 115.7 | 69 | 342.1 | 138.2 | 29 | 397.8 | 160.7 | 89 | 453.4 | 183.2 | 49 | 509.0 | 205.7 |
| 10 | 287.4 | 116.1 | 70 | 343.1 | 138.6 | 30 | 398.7 | 161.1 | 90 | 454.3 | 183.6 | 50 | 510.0 | 206.1 |
| 311 | 288.4 | 116.5 | 371 | 344.0 | 139.0 | 431 | 399.6 | 161.4 | 491 | 455.3 | 184.0 | 551 | 510.9 | 206.5 |
| 12 | 289.3 | 116.8 | 72 | 344.9 | 139.3 | 32 | 400.5 | 161.8 | 92 | 456.2 | 184.3 | 52 | 511.8 | 206.8 |
| 13 | 290.2 | 117.2 | 73 | 345.8 | 139.7 | 33 | 401.5 | 162.2 | 93 | 457.1 | 184.7 | 53 | 512.7 | 207.2 |
| 14 | 291.1 | 117.6 | 74 | 346.8 | 140.1 | 34 | 402.4 | 162.6 | 94 | 458.0 | 185.1 | 54 | 513.6 | 207.6 |
| 15 | 292.1 | 118.0 | 75 | 347.7 | 140.5 | 35 | 403.3 | 162.9 | 95 | 459.0 | 185.4 | 55 | 514.6 | 208.0 |
| 16 | 293.0 | 118.3 | 76 | 348.6 | 140.8 | 36 | 404.3 | 163.3 | 96 | 459.9 | 185.8 | 56 | 515.5 | 208.3 |
| 17 | 293.9 | 118.7 | 77 | 349.5 | 141.2 | 37 | 405.2 | 163.7 | 97 | 460.8 | 186.2 | 57 | 516.4 | 208.7 |
| 18 | 294.8 | 119.1 | 78 | 350.5 | 141.6 | 38 | 406.1 | 164.1 | 98 | 461.8 | 186.6 | 58 | 517.4 | 209.1 |
| 19 | 295.8 | 119.5 | 79 | 351.4 | 141.9 | 39 | 407.0 | 164.4 | 99 | 462.7 | 186.9 | 59 | 518.3 | 209.4 |
| 20 | 296.7 | 119.8 | 80 | 352.3 | 142.3 | 40 | 408.0 | 164.8 | 500 | 463.6 | 187.3 | 60 | 519.2 | 209.8 |
| 321 | 297.6 | 120.2 | 381 | 353.3 | 142.7 | 441 | 408.9 | 165.2 | 501 | 464.5 | 187.7 | 561 | 520.1 | 210.2 |
| 22 | 298.6 | 120.6 | 82 | 354.2 | 143.1 | 42 | 409.8 | 165.5 | 02 | 465.4 | 188.0 | 62 | 521.0 | 210.5 |
| 23 | 299.5 | 121.0 | 83 | 355.1 | 143.4 | 43 | 410.7 | 165.9 | 03 | 466.4 | 188.4 | 63 | 522.0 | 210.9 |
| 24 | 300.4 | 121.3 | 84 | 356.0 | 143.8 | 44 | 411.7 | 166.3 | 04 | 467.3 | 188.8 | 64 | 522.9 | 211.3 |
| 25 | 301.3 | 121.7 | 85 | 357.0 | 144.2 | 45 | 412.6 | 166.7 | 05 | 468.2 | 189.2 | 65 | 523.8 | 211.7 |
| 26 | 302.3 | 122.1 | 86 | 357.9 | 144.6 | 46 | 413.5 | 167.0 | 06 | 469.2 | 189.5 | 66 | 524.8 | 212.0 |
| 27 | 303.2 | 122.5 | 87 | 358.8 | 144.9 | 47 | 414.5 | 167.4 | 07 | 470.1 | 189.9 | 67 | 525.7 | 212.4 |
| 28 | 304.1 | 122.8 | 88 | 359.7 | 145.3 | 48 | 415.4 | 167.8 | 08 | 471.0 | 190.3 | 68 | 526.6 | 212.8 |
| 29 | 305.0 | 123.2 | 89 | 360.7 | 145.7 | 49 | 416.3 | 168.2 | 09 | 471.9 | 190.7 | 69 | 527.5 | 213.2 |
| 30 | 306.0 | 123.6 | 90 | 361.6 | 146.1 | 50 | 417.2 | 168.5 | 10 | 472.9 | 191.1 | 70 | 528.5 | 213.5 |
| 331 | 306.9 | 124.0 | 391 | 362.5 | 146.4 | 451 | 418.2 | 168.9 | 511 | 473.8 | 191.4 | 571 | 529.4 | 213.9 |
| 32 | 307.8 | 124.3 | 92 | 363.5 | 146.8 | 52 | 419.1 | 169.3 | 12 | 474.7 | 191.8 | 72 | 530.3 | 214.3 |
| 33 | 308.8 | 124.7 | 93 | 364.4 | 147.2 | 53 | 420.0 | 169.7 | 13 | 475.6 | 192.2 | 73 | 531.2 | 214.7 |
| 34 | 309.7 | 125.1 | 94 | 365.3 | 147.6 | 54 | 420.9 | 170.0 | 14 | 476.6 | 192.5 | 74 | 532.2 | 215.0 |
| 35 | 310.6 | 125.5 | 95 | 366.2 | 147.9 | 55 | 421.9 | 170.4 | 15 | 477.5 | 192.9 | 75 | 533.1 | 215.4 |
| 36 | 311.5 | 125.8 | 96 | 367.2 | 148.3 | 56 | 422.8 | 170.8 | 16 | 478.4 | 193.3 | 76 | 534.0 | 215.8 |
| 37 | 312.5 | 126.2 | 97 | 368.1 | 148.7 | 57 | 423.7 | 171.2 | 17 | 479.3 | 193.7 | 77 | 534.9 | 216.2 |
| 38 | 313.4 | 126.6 | 98 | 369.0 | 149.1 | 58 | 424.6 | 171.5 | 18 | 480.3 | 194.0 | 78 | 535.9 | 216.5 |
| 39 | 314.3 | 127.0 | 99 | 369.9 | 149.4 | 59 | 425.6 | 171.9 | 19 | 481.2 | 194.4 | 79 | 536.8 | 216.9 |
| 40 | 315.2 | 127.3 | 400 | 370.9 | 149.8 | 60 | 426.5 | 172.3 | 20 | 482.1 | 194.8 | 80 | 537.7 | 217.3 |
| 341 | 316.2 | 127.7 | 401 | 371.8 | 150.2 | 461 | 427.4 | 172.7 | 521 | 483.0 | 195.2 | 581 | 538.6 | 217.7 |
| 42 | 317.1 | 128.1 | 02 | 372.7 | 150.6 | 62 | 428.4 | 173.0 | 22 | 484.0 | 195.5 | 82 | 539.6 | 218.0 |
| 43 | 318.0 | 128.5 | 03 | 373.7 | 150.9 | 63 | 429.3 | 173.4 | 23 | 484.9 | 195.9 | 83 | 540.5 | 218.4 |
| 44 | 319.0 | 128.8 | 04 | 374.6 | 151.3 | 64 | 430.2 | 173.8 | 24 | 485.8 | 196.3 | 84 | 541.4 | 218.8 |
| 45 | 319.9 | 129.2 | 05 | 375.5 | 151.7 | 65 | 431.1 | 174.2 | 25 | 486.7 | 196.7 | 85 | 542.4 | 219.2 |
| 46 | 320.8 | 129.6 | 06 | 376.4 | 152.1 | 66 | 432.1 | 174.5 | 26 | 487.7 | 197.0 | 86 | 543.3 | 219.5 |
| 47 | 321.7 | 130.0 | 07 | 377.4 | 152.4 | 67 | 433.0 | 174.9 | 27 | 488.6 | 197.4 | 87 | 544.2 | 219.9 |
| 48 | 322.7 | 130.3 | 08 | 378.3 | 152.8 | 68 | 433.9 | 175.3 | 28 | 489.5 | 197.8 | 88 | 545.1 | 220.3 |
| 49 | 323.6 | 130.7 | 09 | 379.2 | 153.2 | 69 | 434.8 | 175.7 | 29 | 490.4 | 198.2 | 89 | 546.1 | 220.7 |
| 50 | 324.5 | 131.1 | 10 | 380.1 | 153.6 | 70 | 435.8 | 176.0 | 30 | 491.4 | 198.5 | 90 | 547.0 | 221.0 |
| 351 | 325.4 | 131.5 | 411 | 381.1 | 153.9 | 471 | 436.7 | 176.4 | 531 | 492.3 | 198.9 | 591 | 547.9 | 221.4 |
| 52 | 326.4 | 131.8 | 12 | 382.0 | 154.3 | 72 | 437.6 | 176.8 | 32 | 493.2 | 199.3 | 92 | 548.9 | 221.8 |
| 53 | 327.3 | 132.2 | 13 | 382.9 | 154.7 | 73 | 438.6 | 177.2 | 33 | 494.2 | 199.7 | 93 | 549.8 | 222.2 |
| 54 | 328.2 | 132.6 | 14 | 383.9 | 155.1 | 74 | 439.5 | 177.5 | 34 | 495.1 | 200.0 | 94 | 550.7 | 222.5 |
| 55 | 329.2 | 133.0 | 15 | 384.8 | 155.4 | 75 | 440.4 | 177.9 | 35 | 496.0 | 200.4 | 95 | 551.7 | 222.9 |
| 56 | 330.1 | 133.3 | 16 | 385.7 | 155.8 | 76 | 441.3 | 178.3 | 36 | 496.9 | 200.8 | 96 | 552.6 | 223.3 |
| 57 | 331.0 | 133.7 | 17 | 386.6 | 156.2 | 77 | 442.3 | 178.7 | 37 | 497.9 | 201.2 | 97 | 553.5 | 223.7 |
| 58 | 332.0 | 134.1 | 18 | 387.6 | 156.6 | 78 | 443.2 | 179.0 | 38 | 498.8 | 201.5 | 98 | 554.4 | 224.0 |
| 59 | 332.9 | 134.5 | 19 | 388.5 | 156.9 | 79 | 444.1 | 179.4 | 39 | 499.7 | 201.9 | 99 | 555.4 | 224.4 |
| 60 | 333.8 | 134.8 | 20 | 389.4 | 157.3 | 80 | 445.0 | 179.8 | 40 | 500.7 | 202.3 | 600 | 556.3 | 224.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

68° (112°, 248°, 292°).

# TABLE 2.

Difference of Latitude and Departure for 23° (157°, 203°, 337°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 56.2 | 23.8 | 121 | 111.4 | 47.3 | 181 | 166.6 | 70.7 | 241 | 221.8 | 94.2 |
| 2 | 1.8 | 0.8 | 62 | 57.1 | 24.2 | 22 | 112.3 | 47.7 | 82 | 167.5 | 71.1 | 42 | 222.8 | 94.6 |
| 3 | 2.8 | 1.2 | 63 | 58.0 | 24.6 | 23 | 113.2 | 48.1 | 83 | 168.5 | 71.5 | 43 | 223.7 | 94.9 |
| 4 | 3.7 | 1.6 | 64 | 58.9 | 25.0 | 24 | 114.1 | 48.5 | 84 | 169.4 | 71.9 | 44 | 224.6 | 95.3 |
| 5 | 4.6 | 2.0 | 65 | 59.8 | 25.4 | 25 | 115.1 | 48.8 | 85 | 170.3 | 72.3 | 45 | 225.5 | 95.7 |
| 6 | 5.5 | 2.3 | 66 | 60.8 | 25.8 | 26 | 116.0 | 49.2 | 86 | 171.2 | 72.7 | 46 | 226.4 | 96.1 |
| 7 | 6.4 | 2.7 | 67 | 61.7 | 26.2 | 27 | 116.9 | 49.6 | 87 | 172.1 | 73.1 | 47 | 227.4 | 96.5 |
| 8 | 7.4 | 3.1 | 68 | 62.6 | 26.6 | 28 | 117.8 | 50.0 | 88 | 173.1 | 73.5 | 48 | 228.3 | 96.9 |
| 9 | 8.3 | 3.5 | 69 | 63.5 | 27.0 | 29 | 118.7 | 50.4 | 89 | 174.0 | 73.8 | 49 | 229.2 | 97.3 |
| 10 | 9.2 | 3.9 | 70 | 64.4 | 27.4 | 30 | 119.7 | 50.8 | 90 | 174.9 | 74.2 | 50 | 230.1 | 97.7 |
| 11 | 10.1 | 4.3 | 71 | 65.4 | 27.7 | 131 | 120.6 | 51.2 | 191 | 175.8 | 74.6 | 251 | 231.0 | 98.1 |
| 12 | 11.0 | 4.7 | 72 | 66.3 | 28.1 | 32 | 121.5 | 51.6 | 92 | 176.7 | 75.0 | 52 | 232.0 | 98.5 |
| 13 | 12.0 | 5.1 | 73 | 67.2 | 28.5 | 33 | 122.4 | 52.0 | 93 | 177.7 | 75.4 | 53 | 232.9 | 98.9 |
| 14 | 12.9 | 5.5 | 74 | 68.1 | 28.9 | 34 | 123.3 | 52.4 | 94 | 178.6 | 75.8 | 54 | 233.8 | 99.2 |
| 15 | 13.8 | 5.9 | 75 | 69.0 | 29.3 | 35 | 124.3 | 52.7 | 95 | 179.5 | 76.2 | 55 | 234.7 | 99.6 |
| 16 | 14.7 | 6.3 | 76 | 70.0 | 29.7 | 36 | 125.2 | 53.1 | 96 | 180.4 | 76.6 | 56 | 235.6 | 100.0 |
| 17 | 15.6 | 6.6 | 77 | 70.9 | 30.1 | 37 | 126.1 | 53.5 | 97 | 181.3 | 77.0 | 57 | 236.6 | 100.4 |
| 18 | 16.6 | 7.0 | 78 | 71.8 | 30.5 | 38 | 127.0 | 53.9 | 98 | 182.3 | 77.4 | 58 | 237.5 | 100.8 |
| 19 | 17.5 | 7.4 | 79 | 72.7 | 30.9 | 39 | 128.0 | 54.3 | 99 | 183.2 | 77.8 | 59 | 238.4 | 101.2 |
| 20 | 18.4 | 7.8 | 80 | 73.6 | 31.3 | 40 | 128.9 | 54.7 | 200 | 184.1 | 78.1 | 60 | 239.3 | 101.6 |
| 21 | 19.3 | 8.2 | 81 | 74.6 | 31.6 | 141 | 129.8 | 55.1 | 201 | 185.0 | 78.5 | 261 | 240.3 | 102.0 |
| 22 | 20.3 | 8.6 | 82 | 75.5 | 32.0 | 42 | 130.7 | 55.5 | 02 | 185.9 | 78.9 | 62 | 241.2 | 102.4 |
| 23 | 21.2 | 9.0 | 83 | 76.4 | 32.4 | 43 | 131.6 | 55.9 | 03 | 186.9 | 79.3 | 63 | 242.1 | 102.8 |
| 24 | 22.1 | 9.4 | 84 | 77.3 | 32.8 | 44 | 132.6 | 56.3 | 04 | 187.8 | 79.7 | 64 | 243.0 | 103.2 |
| 25 | 23.0 | 9.8 | 85 | 78.2 | 33.2 | 45 | 133.5 | 56.7 | 05 | 188.7 | 80.1 | 65 | 243.9 | 103.5 |
| 26 | 23.9 | 10.2 | 86 | 79.2 | 33.6 | 46 | 134.4 | 57.0 | 06 | 189.6 | 80.5 | 66 | 244.9 | 103.9 |
| 27 | 24.9 | 10.5 | 87 | 80.1 | 34.0 | 47 | 135.3 | 57.4 | 07 | 190.5 | 80.9 | 67 | 245.8 | 104.3 |
| 28 | 25.8 | 10.9 | 88 | 81.0 | 34.4 | 48 | 136.2 | 57.8 | 08 | 191.5 | 81.3 | 68 | 246.7 | 104.7 |
| 29 | 26.7 | 11.3 | 89 | 81.9 | 34.8 | 49 | 137.2 | 58.2 | 09 | 192.4 | 81.7 | 69 | 247.6 | 105.1 |
| 30 | 27.6 | 11.7 | 90 | 82.8 | 35.2 | 50 | 138.1 | 58.6 | 10 | 193.3 | 82.1 | 70 | 248.5 | 105.5 |
| 31 | 28.5 | 12.1 | 91 | 83.8 | 35.6 | 151 | 139.0 | 59.0 | 211 | 194.2 | 82.4 | 271 | 249.5 | 105.9 |
| 32 | 29.5 | 12.5 | 92 | 84.7 | 35.9 | 52 | 139.9 | 59.4 | 12 | 195.1 | 82.8 | 72 | 250.4 | 106.3 |
| 33 | 30.4 | 12.9 | 93 | 85.6 | 36.3 | 53 | 140.8 | 59.8 | 13 | 196.1 | 83.2 | 73 | 251.3 | 106.7 |
| 34 | 31.3 | 13.3 | 94 | 86.5 | 36.7 | 54 | 141.8 | 60.2 | 14 | 197.0 | 83.6 | 74 | 252.2 | 107.1 |
| 35 | 32.2 | 13.7 | 95 | 87.4 | 37.1 | 55 | 142.7 | 60.6 | 15 | 197.9 | 84.0 | 75 | 253.1 | 107.5 |
| 36 | 33.1 | 14.1 | 96 | 88.4 | 37.5 | 56 | 143.6 | 61.0 | 16 | 198.8 | 84.4 | 76 | 254.1 | 107.8 |
| 37 | 34.1 | 14.5 | 97 | 89.3 | 37.9 | 57 | 144.5 | 61.3 | 17 | 199.7 | 84.8 | 77 | 255.0 | 108.2 |
| 38 | 35.0 | 14.8 | 98 | 90.2 | 38.3 | 58 | 145.4 | 61.7 | 18 | 200.7 | 85.2 | 78 | 255.9 | 108.6 |
| 39 | 35.9 | 15.2 | 99 | 91.1 | 38.7 | 59 | 146.4 | 62.1 | 19 | 201.6 | 85.6 | 79 | 256.8 | 109.0 |
| 40 | 36.8 | 15.6 | 100 | 92.1 | 39.1 | 60 | 147.3 | 62.5 | 20 | 202.5 | 86.0 | 80 | 257.7 | 109.4 |
| 41 | 37.7 | 16.0 | 101 | 93.0 | 39.5 | 161 | 148.2 | 62.9 | 221 | 203.4 | 86.4 | 281 | 258.7 | 109.8 |
| 42 | 38.7 | 16.4 | 02 | 93.9 | 39.9 | 62 | 149.1 | 63.3 | 22 | 204.4 | 86.7 | 82 | 259.6 | 110.2 |
| 43 | 39.6 | 16.8 | 03 | 94.8 | 40.2 | 63 | 150.0 | 63.7 | 23 | 205.3 | 87.1 | 83 | 260.5 | 110.6 |
| 44 | 40.5 | 17.2 | 04 | 95.7 | 40.6 | 64 | 151.0 | 64.1 | 24 | 206.2 | 87.5 | 84 | 261.4 | 111.0 |
| 45 | 41.4 | 17.6 | 05 | 96.7 | 41.0 | 65 | 151.9 | 64.5 | 25 | 207.1 | 87.9 | 85 | 262.3 | 111.4 |
| 46 | 42.3 | 18.0 | 06 | 97.6 | 41.4 | 66 | 152.8 | 64.9 | 26 | 208.0 | 88.3 | 86 | 263.3 | 111.7 |
| 47 | 43.3 | 18.4 | 07 | 98.5 | 41.8 | 67 | 153.7 | 65.3 | 27 | 209.0 | 88.7 | 87 | 264.2 | 112.1 |
| 48 | 44.2 | 18.8 | 08 | 99.4 | 42.2 | 68 | 154.6 | 65.6 | 28 | 209.9 | 89.1 | 88 | 265.1 | 112.5 |
| 49 | 45.1 | 19.1 | 09 | 100.3 | 42.6 | 69 | 155.6 | 66.0 | 29 | 210.8 | 89.5 | 89 | 266.0 | 112.9 |
| 50 | 46.0 | 19.5 | 10 | 101.3 | 43.0 | 70 | 156.5 | 66.4 | 30 | 211.7 | 89.9 | 90 | 266.9 | 113.3 |
| 51 | 46.9 | 19.9 | 111 | 102.2 | 43.4 | 171 | 157.4 | 66.8 | 231 | 212.6 | 90.3 | 291 | 267.9 | 113.7 |
| 52 | 47.9 | 20.3 | 12 | 103.1 | 43.8 | 72 | 158.3 | 67.2 | 32 | 213.6 | 90.6 | 92 | 268.8 | 114.1 |
| 53 | 48.8 | 20.7 | 13 | 104.0 | 44.2 | 73 | 159.2 | 67.6 | 33 | 214.5 | 91.0 | 93 | 269.7 | 114.5 |
| 54 | 49.7 | 21.1 | 14 | 104.9 | 44.5 | 74 | 160.2 | 68.0 | 34 | 215.4 | 91.4 | 94 | 270.6 | 114.9 |
| 55 | 50.6 | 21.5 | 15 | 105.9 | 44.9 | 75 | 161.1 | 68.4 | 35 | 216.3 | 91.8 | 95 | 271.5 | 115.3 |
| 56 | 51.5 | 21.9 | 16 | 106.8 | 45.3 | 76 | 162.0 | 68.8 | 36 | 217.2 | 92.2 | 96 | 272.5 | 115.7 |
| 57 | 52.5 | 22.3 | 17 | 107.7 | 45.7 | 77 | 162.9 | 69.2 | 37 | 218.2 | 92.6 | 97 | 273.4 | 116.0 |
| 58 | 53.4 | 22.7 | 18 | 108.6 | 46.1 | 78 | 163.8 | 69.6 | 38 | 219.1 | 93.0 | 98 | 274.3 | 116.4 |
| 59 | 54.3 | 23.1 | 19 | 109.5 | 46.5 | 79 | 164.8 | 69.9 | 39 | 220.0 | 93.4 | 99 | 275.2 | 116.8 |
| 60 | 55.2 | 23.4 | 20 | 110.5 | 46.9 | 80 | 165.7 | 70.3 | 40 | 220.9 | 93.8 | 300 | 276.2 | 117.2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

67° (113°, 247°, 293°).

TABLE 2. [Page 413

Difference of Latitude and Departure for 23° (157°, 203°, 337°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 277.1 | 117.6 | 361 | 332.3 | 141.1 | 421 | 387.5 | 164.5 | 481 | 442.7 | 188.0 | 541 | 498.0 | 211.4 |
| 02 | 278.0 | 118.0 | 62 | 333.2 | 141.5 | 22 | 388.5 | 164.9 | 82 | 443.7 | 188.4 | 42 | 498.9 | 211.8 |
| 03 | 278.9 | 118.4 | 63 | 334.1 | 141.8 | 23 | 389.4 | 165.3 | 83 | 444.6 | 188.8 | 43 | 499.8 | 212.2 |
| 04 | 279.8 | 118.8 | 64 | 335.1 | 142.2 | 24 | 390.3 | 165.7 | 84 | 445.5 | 189.2 | 44 | 500.7 | 212.6 |
| 05 | 280.8 | 119.2 | 65 | 336.0 | 142.6 | 25 | 391.2 | 166.1 | 85 | 446.4 | 189.5 | 45 | 501.7 | 213.0 |
| 06 | 281.7 | 119.6 | 66 | 336.9 | 143.0 | 26 | 392.1 | 166.5 | 86 | 447.3 | 189.9 | 46 | 502.6 | 213.4 |
| 07 | 282.6 | 120.0 | 67 | 337.8 | 143.4 | 27 | 393.1 | 166.8 | 87 | 448.3 | 190.2 | 47 | 503.5 | 213.8 |
| 08 | 283.5 | 120.4 | 68 | 338.7 | 143.8 | 28 | 394.0 | 167.2 | 88 | 449.2 | 190.6 | 48 | 504.4 | 214.2 |
| 09 | 284.4 | 120.8 | 69 | 339.7 | 144.2 | 29 | 394.9 | 167.6 | 89 | 450.1 | 191.0 | 49 | 505.3 | 214.6 |
| 10 | 285.4 | 121.2 | 70 | 340.6 | 144.6 | 30 | 395.8 | 168.0 | 90 | 451.0 | 191.4 | 50 | 506.3 | 215.0 |
| 311 | 286.3 | 121.6 | 371 | 341.5 | 145.0 | 431 | 396.7 | 168.4 | 491 | 451.9 | 191.8 | 551 | 507.2 | 215.3 |
| 12 | 287.2 | 121.9 | 72 | 342.4 | 145.4 | 32 | 397.7 | 168.8 | 92 | 452.9 | 192.2 | 52 | 508.1 | 215.6 |
| 13 | 288.1 | 122.3 | 73 | 343.4 | 145.7 | 33 | 398.6 | 169.2 | 93 | 453.8 | 192.6 | 53 | 509.0 | 216.0 |
| 14 | 289.0 | 122.7 | 74 | 344.3 | 146.1 | 34 | 399.5 | 169.6 | 94 | 454.7 | 193.0 | 54 | 509.9 | 216.4 |
| 15 | 290.0 | 123.1 | 75 | 345.2 | 146.5 | 35 | 400.4 | 170.0 | 95 | 455.6 | 193.4 | 55 | 510.9 | 216.8 |
| 16 | 290.9 | 123.5 | 76 | 346.1 | 146.9 | 36 | 401.3 | 170.4 | 96 | 456.6 | 193.8 | 56 | 511.8 | 217.2 |
| 17 | 291.8 | 123.9 | 77 | 347.0 | 147.3 | 37 | 402.3 | 170.8 | 97 | 457.5 | 194.2 | 57 | 512.7 | 217.6 |
| 18 | 292.7 | 124.3 | 78 | 348.0 | 147.7 | 38 | 403.2 | 171.1 | 98 | 458.4 | 194.6 | 58 | 513.6 | 218.0 |
| 19 | 293.6 | 124.6 | 79 | 348.9 | 148.1 | 39 | 404.1 | 171.5 | 99 | 459.3 | 195.0 | 59 | 514.5 | 218.4 |
| 20 | 294.6 | 125.0 | 80 | 349.8 | 148.5 | 40 | 405.0 | 171.9 | 500 | 460.2 | 195.4 | 60 | 515.5 | 218.8 |
| 321 | 295.5 | 125.4 | 381 | 350.7 | 148.9 | 441 | 405.9 | 172.3 | 501 | 461.2 | 195.8 | 561 | 516.4 | 219.2 |
| 22 | 296.4 | 125.8 | 82 | 351.6 | 149.3 | 42 | 406.9 | 172.7 | 02 | 462.1 | 196.2 | 62 | 517.3 | 219.6 |
| 23 | 297.3 | 126.2 | 83 | 352.6 | 149.7 | 43 | 407.8 | 173.1 | 03 | 463.0 | 196.6 | 63 | 518.2 | 220.0 |
| 24 | 298.2 | 126.6 | 84 | 353.5 | 150.0 | 44 | 408.7 | 173.5 | 04 | 463.9 | 197.0 | 64 | 519.2 | 220.4 |
| 25 | 299.2 | 127.0 | 85 | 354.4 | 150.4 | 45 | 409.6 | 173.9 | 05 | 464.9 | 197.4 | 65 | 520.1 | 220.8 |
| 26 | 300.1 | 127.4 | 86 | 355.3 | 150.8 | 46 | 410.5 | 174.3 | 06 | 465.8 | 197.8 | 66 | 521.0 | 221.2 |
| 27 | 301.0 | 127.8 | 87 | 356.2 | 151.2 | 47 | 411.5 | 174.7 | 07 | 466.7 | 198.1 | 67 | 521.9 | 221.6 |
| 28 | 301.9 | 128.2 | 88 | 357.2 | 151.6 | 48 | 412.4 | 175.1 | 08 | 467.6 | 198.5 | 68 | 522.8 | 222.0 |
| 29 | 302.8 | 128.6 | 89 | 358.1 | 152.0 | 49 | 413.3 | 175.4 | 09 | 468.5 | 198.8 | 69 | 523.8 | 222.3 |
| 30 | 303.8 | 128.9 | 90 | 359.0 | 152.4 | 50 | 414.2 | 175.8 | 10 | 469.5 | 199.3 | 70 | 524.7 | 222.7 |
| 331 | 304.7 | 129.3 | 391 | 359.9 | 152.8 | 451 | 415.2 | 176.2 | 511 | 470.4 | 199.7 | 571 | 525.6 | 223.1 |
| 32 | 305.6 | 129.7 | 92 | 360.8 | 153.2 | 52 | 416.1 | 176.6 | 12 | 471.3 | 200.0 | 72 | 526.5 | 223.4 |
| 33 | 306.5 | 130.1 | 93 | 361.8 | 153.6 | 53 | 417.0 | 177.0 | 13 | 472.2 | 200.4 | 73 | 527.4 | 223.8 |
| 34 | 307.5 | 130.5 | 94 | 362.7 | 154.0 | 54 | 417.9 | 177.4 | 14 | 473.1 | 200.8 | 74 | 528.4 | 224.2 |
| 35 | 308.4 | 130.9 | 95 | 363.6 | 154.3 | 55 | 418.8 | 177.8 | 15 | 474.0 | 201.2 | 75 | 529.3 | 224.6 |
| 36 | 309.3 | 131.3 | 96 | 364.5 | 154.7 | 56 | 419.8 | 178.2 | 16 | 475.0 | 201.6 | 76 | 530.2 | 225.0 |
| 37 | 310.2 | 131.7 | 97 | 365.4 | 155.1 | 57 | 420.7 | 178.6 | 17 | 475.9 | 202.0 | 77 | 531.1 | 225.4 |
| 38 | 311.1 | 132.1 | 98 | 366.4 | 155.5 | 58 | 421.6 | 179.0 | 18 | 476.8 | 202.4 | 78 | 532.0 | 225.8 |
| 39 | 312.1 | 132.5 | 99 | 367.3 | 155.9 | 59 | 422.5 | 179.4 | 19 | 477.7 | 202.8 | 79 | 533.0 | 226.2 |
| 40 | 313.0 | 132.9 | 400 | 368.2 | 156.3 | 60 | 423.4 | 179.7 | 20 | 478.6 | 203.2 | 80 | 533.9 | 226.6 |
| 341 | 313.9 | 133.2 | 401 | 369.1 | 156.7 | 461 | 424.4 | 180.1 | 521 | 479.6 | 203.6 | 581 | 534.8 | 227.0 |
| 42 | 314.8 | 133.6 | 02 | 370.0 | 157.1 | 62 | 425.3 | 180.5 | 22 | 480.5 | 204.0 | 82 | 535.7 | 227.4 |
| 43 | 315.7 | 134.0 | 03 | 371.0 | 157.5 | 63 | 426.2 | 180.9 | 23 | 481.4 | 204.4 | 83 | 536.6 | 227.8 |
| 44 | 316.7 | 134.4 | 04 | 371.9 | 157.9 | 64 | 427.1 | 181.3 | 24 | 482.3 | 204.8 | 84 | 537.6 | 228.2 |
| 45 | 317.6 | 134.8 | 05 | 372.8 | 158.3 | 65 | 428.0 | 181.7 | 25 | 483.2 | 205.2 | 85 | 538.5 | 228.6 |
| 46 | 318.5 | 135.2 | 06 | 373.7 | 158.6 | 66 | 429.0 | 182.1 | 26 | 484.2 | 205.5 | 86 | 539.4 | 229.0 |
| 47 | 319.4 | 135.6 | 07 | 374.6 | 159.0 | 67 | 429.9 | 182.5 | 27 | 485.1 | 205.9 | 87 | 540.3 | 229.4 |
| 48 | 320.3 | 136.0 | 08 | 375.6 | 159.4 | 68 | 430.8 | 182.9 | 28 | 486.0 | 206.3 | 88 | 541.2 | 229.8 |
| 49 | 321.3 | 136.4 | 09 | 376.5 | 159.8 | 69 | 431.7 | 183.3 | 29 | 486.9 | 206.7 | 89 | 542.2 | 230.2 |
| 50 | 322.2 | 136.8 | 10 | 377.4 | 160.2 | 70 | 432.6 | 183.7 | 30 | 487.8 | 207.1 | 90 | 543.1 | 230.6 |
| 351 | 323.1 | 137.2 | 411 | 378.3 | 160.6 | 471 | 433.6 | 184.0 | 531 | 488.8 | 207.4 | 591 | 544.0 | 231.0 |
| 52 | 324.0 | 137.5 | 12 | 379.3 | 161.0 | 72 | 434.5 | 184.4 | 32 | 489.7 | 207.8 | 92 | 544.9 | 231.3 |
| 53 | 324.9 | 137.9 | 13 | 380.2 | 161.4 | 73 | 435.4 | 184.8 | 33 | 490.6 | 208.2 | 93 | 545.8 | 231.7 |
| 54 | 325.9 | 138.3 | 14 | 381.1 | 161.8 | 74 | 436.3 | 185.2 | 34 | 491.5 | 208.6 | 94 | 546.8 | 232.0 |
| 55 | 326.8 | 138.7 | 15 | 382.0 | 162.2 | 75 | 437.2 | 185.6 | 35 | 492.5 | 209.0 | 95 | 547.7 | 232.4 |
| 56 | 327.7 | 139.1 | 16 | 382.9 | 162.5 | 76 | 438.2 | 186.0 | 36 | 493.4 | 209.4 | 96 | 548.6 | 232.8 |
| 57 | 328.6 | 139.5 | 17 | 383.9 | 162.9 | 77 | 439.1 | 186.4 | 37 | 494.3 | 209.8 | 97 | 549.5 | 233.2 |
| 58 | 329.5 | 139.9 | 18 | 384.8 | 163.3 | 78 | 440.0 | 186.8 | 38 | 495.2 | 210.2 | 98 | 550.4 | 233.6 |
| 59 | 330.5 | 140.3 | 19 | 385.7 | 163.7 | 79 | 440.9 | 187.2 | 39 | 496.1 | 210.6 | 99 | 551.3 | 234.0 |
| 60 | 331.4 | 140.7 | 20 | 386.6 | 164.1 | 80 | 441.8 | 187.6 | 40 | 497.1 | 211.0 | 600 | 552.3 | 234.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

67°(113°, 247°, 293°).

# TABLE 2.

Difference of Latitude and Departure for 24° (156°, 204°, 336°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 55.7 | 24.8 | 121 | 110.5 | 49.2 | 181 | 165.4 | 73.6 | 241 | 220.2 | 98.0 |
| 2 | 1.8 | 0.8 | 62 | 56.6 | 25.2 | 22 | 111.5 | 49.6 | 82 | 166.3 | 74.0 | 42 | 221.1 | 98.4 |
| 3 | 2.7 | 1.2 | 63 | 57.6 | 25.6 | 23 | 112.4 | 50.0 | 83 | 167.2 | 74.4 | 43 | 222.0 | 98.8 |
| 4 | 3.7 | 1.6 | 64 | 58.5 | 26.0 | 24 | 113.3 | 50.4 | 84 | 168.1 | 74.8 | 44 | 222.9 | 99.2 |
| 5 | 4.6 | 2.0 | 65 | 59.4 | 26.4 | 25 | 114.2 | 50.8 | 85 | 169.0 | 75.2 | 45 | 223.8 | 99.7 |
| 6 | 5.5 | 2.4 | 66 | 60.3 | 26.8 | 26 | 115.1 | 51.2 | 86 | 169.9· | 75.7 | 46 | 224.7 | 100.1 |
| 7 | 6.4 | 2.8 | 67 | 61.2 | 27.3 | 27 | 116.0 | 51.7 | 87 | 170.8 | 76.1 | 47 | 225.6 | 100.5 |
| 8 | 7.3 | 3.3 | 68 | 62.1 | 27.7 | 28 | 116.9 | 52.1 | 88 | 171.7 | 76.5 | 48 | 226.6 | 100.9 |
| 9 | 8.2 | 3.7 | 69 | 63.0 | 28.1 | 29 | 117.8 | 52.5 | 89 | 172.7 | 76.9 | 49 | 227.5 | 101.3 |
| 10 | 9.1 | 4.1 | 70 | 63.9 | 28.5 | 30 | 118.8 | 52.9 | 90 | 173.6 | 77.3 | 50 | 228.4 | 101.7 |
| 11 | 10.0 | 4.5 | 71 | 64.9 | 28.9 | 131 | 119.7 | 53.3 | 191 | 174.5 | 77.7 | 251 | 229.3 | 102.1 |
| 12 | 11.0 | 4.9 | 72 | 65.8 | 29.3 | 32 | 120.6 | 53.7 | 92 | 175.4 | 78.1 | 52 | 230.2 | 102.5 |
| 13 | 11.9 | 5.3 | 73 | 66.7 | 29.7 | 33 | 121.5 | 54.1 | 93 | 176.3 | 78.5 | 53 | 231.1 | 102.9 |
| 14 | 12.8 | 5.7 | 74 | 67.6 | 30.1 | 34 | 122.4 | 54.5 | 94 | 177.2 | 78.9 | 54 | 232.0 | 103.3 |
| 15 | 13.7 | 6.1 | 75 | 68.5 | 30.5 | 35 | 123.3 | 54.9 | 95 | 178.1 | 79.3 | 55 | 233.0 | 103.7 |
| 16 | 14.6 | 6.5 | 76 | 69.4 | 30.9 | 36 | 124.2 | 55.3 | 96 | 179.1 | 79.7 | 56 | 233.9 | 104.1 |
| 17 | 15.5 | 6.9 | 77 | 70.3 | 31.3 | 37 | 125.2 | 55.7 | 97 | 180.0 | 80.1 | 57 | 234.8 | 104.5 |
| 18 | 16.4 | 7.3 | 78 | 71.3 | 31.7 | 38 | 126.1 | 56.1 | 98 | 180.9 | 80.5 | 58 | 235.7 | 104.9 |
| 19 | 17.4 | 7.7 | 79 | 72.2 | 32.1 | 39 | 127.0 | 56.5 | 99 | 181.8 | 80.9 | 59 | 236.6 | 105.3 |
| 20 | 18.3 | 8.1 | 80 | 73.1 | 32.5 | 40 | 127.9 | 56.9 | 200 | 182.7 | 81.3 | 60 | 237.5 | 105.8 |
| 21 | 19.2 | 8.5 | 81 | 74.0 | 32.9 | 141 | 128.8 | 57.3 | 201 | 183.6 | 81.8 | 261 | 238.4 | 106.2 |
| 22 | 20.1 | 8.9 | 82 | 74.9 | 33.4 | 42 | 129.7 | 57.8 | 02 | 184.5 | 82.2 | 62 | 239.3 | 106.6 |
| 23 | 21.0 | 9.4 | 83 | 75.8 | 33.8 | 43 | 130.6 | 58.2 | 03 | 185.4 | 82.6 | 63 | 240.3 | 107.0 |
| 24 | 21.9 | 9.8 | 84 | 76.7 | 34.2 | 44 | 131.6 | 58.6 | 04 | 186.4 | 83.0 | 64 | 241.2 | 107.4 |
| 25 | 22.8 | 10.2 | 85 | 77.7 | 34.6 | 45 | 132.5 | 59.0 | 05 | 187.3 | 83.4 | 65 | 242.1 | 107.8 |
| 26 | 23.8 | 10.6 | 86 | 78.6 | 35.0 | 46 | 133.4 | 59.4 | 06 | 188.2 | 83.8 | 66 | 243.0 | 108.2 |
| 27 | 24.7 | 11.0 | 87 | 79.5 | 35.4 | 47 | 134.3 | 59.8 | 07 | 189.1 | 84.2 | 67 | 243.9 | 108.6 |
| 28 | 25.6 | 11.4 | 88 | 80.4 | 35.8 | 48 | 135.2 | 60.2 | 08 | 190.0 | 84.6 | 68 | 244.8 | 109.0 |
| 29 | 26.5 | 11.8 | 89 | 81.3 | 36.2 | 49 | 136.1 | 60.6 | 09 | 190.9 | 85.0 | 69 | 245.7 | 109.4 |
| 30 | 27.4 | 12.2 | 90 | 82.2 | 36.6 | 50 | 137.0 | 61.0 | 10 | 191.8 | 85.4 | 70 | 246.7 | 109.8 |
| 31 | 28.3 | 12.6 | 91 | 83.1 | 37.0 | 151 | 137.9 | 61.4 | 211 | 192.8 | 85.8 | 271 | 247.6 | 110.2 |
| 32 | 29.2 | 13.0 | 92 | 84.0 | 37.4 | 52 | 138.9 | 61.8 | 12 | 193.7 | 86.2 | 72 | 248.5 | 110.6 |
| 33 | 30.1 | 13.4 | 93 | 85.0 | 37.8 | 53 | 139.8 | 62.2 | 13 | 194.6 | 86.6 | 73 | 249.4 | 111.0 |
| 34 | 31.1 | 13.8 | 94 | 85.9 | 38.2 | 54 | 140.7 | 62.6 | 14 | 195.5 | 87.0 | 74 | 250.3 | 111.4 |
| 35 | 32.0 | 14.2 | 95 | 86.8 | 38.6 | 55 | 141.6 | 63.0 | 15 | 196.4 | 87.4 | 75 | 251.2 | 111.9 |
| 36 | 32.9 | 14.6 | 96 | 87.7 | 39.0 | 56 | 142.5 | 63.5 | 16 | 197.3 | 87.9 | 76 | 252.1 | 112.3 |
| 37 | 33.8 | 15.0 | 97 | 88.6 | 39.5 | 57 | 143.4 | 63.9 | 17 | 198.2 | 88.3 | 77 | 253.1 | 112.7 |
| 38 | 34.7 | 15.5 | 98 | 89.5 | 39.9 | 58 | 144.3 | 64.3 | 18 | 199.2 | 88.7 | 78 | 254.0 | 113.1 |
| 39 | 35.6 | 15.9 | 99 | 90.4 | 40.3 | 59 | 145.3 | 64.7 | 19 | 200.1 | 89.1 | 79 | 254.9 | 113.5 |
| 40 | 36.5 | 16.3 | 100 | 91.4 | 40.7 | 60 | 146.2 | 65.1 | 20 | 201.0 | 89.5 | 80 | 255.8 | 113.9 |
| 41 | 37.5 | 16.7 | 101 | 92.3 | 41.1 | 161 | 147.1 | 65.5 | 221 | 201.9 | 89.9 | 281 | 256.7 | 114.3 |
| 42 | 38.4 | 17.1 | 02 | 93.2 | 41.5 | 62 | 148.0 | 65.9 | 22 | 202.8 | 90.3 | 82 | 257.6 | 114.7 |
| 43 | 39.3 | 17.5 | 03 | 94.1 | 41.9 | 63 | 148.9 | 66.3 | 23 | 203.7 | 90.7 | 83 | 258.5 | 115.1 |
| 44 | 40.2 | 17.9 | 04 | 95.0 | 42.3 | 64 | 149.8 | 66.7 | 24 | 204.6 | 91.1 | 84 | 259.4 | 115.5 |
| 45 | 41.1 | 18.3 | 05 | 95.9 | 42.7 | 65 | 150.7 | 67.1 | 25 | 205.5 | 91.5 | 85 | 260.4 | 115.9 |
| 46 | 42.0 | 18.7 | 06 | 96.8 | 43.1 | 66 | 151.6 | 67.5 | 26 | 206.5 | 91.9 | 86 | 261.3 | 116.3 |
| 47 | 42.9 | 19.1 | 07 | 97.7 | 43.5 | 67 | 152.6 | 67.9 | 27 | 207.4 | 92.3 | 87 | 262.2 | 116.7 |
| 48 | 43.9 | 19.5 | 08 | 98.7 | 43.9 | 68 | 153.5 | 68.3 | 28 | 208.3 | 92.7 | 88 | 263.1 | 117.1 |
| 49 | 44.8 | 19.9 | 09 | 99.6 | 44.3 | 69 | 154.4 | 68.7 | 29 | 209.2 | 93.1 | 89 | 264.0 | 117.5 |
| 50 | 45.7 | 20.3 | 10 | 100.5 | 44.7 | 70 | 155.3 | 69.1 | 30 | 210.1 | 93.5 | 90 | 264.9 | 118.0 |
| 51 | 46.6 | 20.7 | 111 | 101.4 | 45.1 | 171 | 156.2 | 69.6 | 231 | 211.0 | 94.0 | 291 | 265.8 | 118.4 |
| 52 | 47.5 | 21.2 | 12 | 102.3 | 45.6 | 72 | 157.1 | 70.0 | 32 | 211.9 | 94.4 | 92 | 266.8 | 118.8 |
| 53 | 48.4 | 21.6 | 13 | 103.2 | 46.0 | 73 | 158.0 | 70.4 | 33 | 212.9 | 94.8 | 93 | 267.7 | 119.2 |
| 54 | 49.3 | 22.0 | 14 | 104.1 | 46.4 | 74 | 159.0 | 70.8 | 34 | 213.8 | 95.2 | 94 | 268.6 | 119.6 |
| 55 | 50.2 | 22.4 | 15 | 105.1 | 46.8 | 75 | 159.9 | 71.2 | 35 | 214.7 | 95.6 | 95 | 269.5 | 120.0 |
| 56 | 51.2 | 22.8 | 16 | 106.0 | 47.2 | 76 | 160.8 | 71.6 | 36 | 215.6 | 96.0 | 96 | 270.4 | 120.4 |
| 57 | 52.1 | 23.2 | 17 | 106.9 | 47.6 | 77 | 161.7 | 72.0 | 37 | 216.5 | 96.4 | 97 | 271.3 | 120.8 |
| 58 | 53.0 | 23.6 | 18 | 107.8 | 48.0 | 78 | 162.6 | 72.4 | 38 | 217.4 | 96.8 | 98 | 272.2 | 121.2 |
| 59 | 53.9 | 24.0 | 19 | 108.7 | 48.4 | 79 | 163.5 | 72.8 | 38 | 218.3 | 97.2 | 99 | 273.2 | 121.6 |
| 60 | 54.8 | 24.4 | 20 | 109.6 | 48.8 | 80 | 164.4 | 73.2 | 40 | 219.3 | 97.6 | 300 | 274.1 | 122.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

66° (114°, 246°, 294°).

TABLE 2. [Page 415

Difference of Latitude and Departure for 24° (156°, 204°, 336°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 275.0 | 122.4 | 361 | 329.8 | 146.8 | 421 | 384.6 | 171.2 | 481 | 439.4 | 195.6 | 541 | 494.2 | 220.0 |
| 02 | 275.9 | 122.8 | 62 | 330.7 | 147.2 | 22 | 385.5 | 171.6 | 82 | 440.3 | 196.0 | 42 | 495.1 | 220.4 |
| 03 | 276.8 | 123.2 | 63 | 331.6 | 147.6 | 23 | 386.4 | 172.1 | 83 | 441.2 | 196.5 | 43 | 496.0 | 220.9 |
| 04 | 277.7 | 123.7 | 64 | 332.5 | 148.1 | 24 | 387.3 | 172.5 | 84 | 442.1 | 196.9 | 44 | 496.9 | 221.3 |
| 05 | 278.6 | 124.1 | 65 | 333.4 | 148.5 | 25 | 388.2 | 172.9 | 85 | 443.0 | 197.3 | 45 | 497.8 | 221.7 |
| 06 | 279.5 | 124.5 | 66 | 334.3 | 148.9 | 26 | 389.2 | 173.3 | 86 | 444.0 | 197.7 | 46 | 498.8 | 222.1 |
| 07 | 280.4 | 124.9 | 67 | 335.3 | 149.3 | 27 | 390.1 | 173.7 | 87 | 444.9 | 198.1 | 47 | 499.7 | 222.5 |
| 08 | 281.4 | 125.3 | 68 | 336.2 | 149.7 | 28 | 391.0 | 174.1 | 88 | 445.8 | 198.5 | 48 | 500.6 | 222.9 |
| 09 | 282.3 | 125.7 | 69 | 337.1 | 150.1 | 29 | 391.9 | 174.5 | 89 | 446.7 | 198.9 | 49 | 501.5 | 223.3 |
| 10 | 283.2 | 126.1 | 70 | 338.0 | 150.5 | 30 | 392.8 | 174.9 | 90 | 447.6 | 199.3 | 50 | 502.4 | 223.7 |
| 311 | 284.1 | 126.5 | 371 | 338.9 | 150.9 | 431 | 393.7 | 175.3 | 491 | 448.6 | 199.7 | 551 | 503.4 | 224.1 |
| 12 | 285.0 | 126.9 | 72 | 339.8 | 151.3 | 32 | 394.6 | 175.7 | 92 | 449.5 | 200.1 | 52 | 504.3 | 224.5 |
| 13 | 285.9 | 127.3 | 73 | 340.7 | 151.7 | 33 | 395.6 | 176.1 | 93 | 450.4 | 200.5 | 53 | 505.2 | 224.9 |
| 14 | 286.8 | 127.7 | 74 | 341.7 | 152.1 | 34 | 396.5 | 176.5 | 94 | 451.3 | 200.9 | 54 | 506.1 | 225.3 |
| 15 | 287.8 | 128.1 | 75 | 342.6 | 152.5 | 35 | 397.4 | 176.9 | 95 | 452.2 | 201.3 | 55 | 507.0 | 225.7 |
| 16 | 288.7 | 128.5 | 76 | 343.5 | 152.9 | 36 | 398.3 | 177.3 | 96 | 453.1 | 201.7 | 56 | 507.9 | 226.1 |
| 17 | 289.6 | 128.9 | 77 | 344.4 | 153.3 | 37 | 399.2 | 177.7 | 97 | 454.0 | 202.2 | 57 | 508.8 | 226.6 |
| 18 | 290.5 | 129.3 | 78 | 345.3 | 153.7 | 38 | 400.1 | 178.2 | 98 | 454.9 | 202.6 | 58 | 509.7 | 227.0 |
| 19 | 291.4 | 129.8 | 79 | 346.2 | 154.2 | 39 | 401.0 | 178.6 | 99 | 455.8 | 203.0 | 59 | 510.6 | 227.4 |
| 20 | 292.3 | 130.2 | 80 | 347.1 | 154.6 | 40 | 402.0 | 179.0 | 500 | 456.8 | 203.4 | 60 | 511.6 | 227.8 |
| 321 | 293.2 | 130.6 | 381 | 348.1 | 155.0 | 441 | 402.9 | 179.4 | 501 | 457.7 | 203.8 | 561 | 512.5 | 228.2 |
| 22 | 294.2 | 131.0 | 82 | 349.0 | 155.4 | 42 | 403.8 | 179.8 | 02 | 458.6 | 204.2 | 62 | 513.4 | 228.6 |
| 23 | 295.1 | 131.4 | 83 | 349.9 | 155.8 | 43 | 404.7 | 180.2 | 03 | 459.5 | 204.6 | 63 | 514.3 | 229.0 |
| 24 | 296.0 | 131.8 | 84 | 350.8 | 156.2 | 44 | 405.6 | 180.6 | 04 | 460.4 | 205.0 | 64 | 515.2 | 229.4 |
| 25 | 296.9 | 132.2 | 85 | 351.7 | 156.6 | 45 | 406.5 | 181.0 | 05 | 461.3 | 205.4 | 65 | 516.1 | 229.8 |
| 26 | 297.8 | 132.6 | 86 | 352.6 | 157.0 | 46 | 407.4 | 181.4 | 06 | 462.2 | 205.8 | 66 | 517.0 | 230.2 |
| 27 | 298.7 | 133.0 | 87 | 353.5 | 157.4 | 47 | 408.3 | 181.8 | 07 | 463.2 | 206.2 | 67 | 518.0 | 230.6 |
| 28 | 299.6 | 133.4 | 88 | 354.4 | 157.8 | 48 | 409.3 | 182.2 | 08 | 464.1 | 206.6 | 68 | 518.9 | 231.0 |
| 29 | 300.5 | 133.8 | 89 | 355.4 | 158.2 | 49 | 410.2 | 182.6 | 09 | 465.0 | 207.0 | 69 | 519.8 | 231.4 |
| 30 | 301.5 | 134.2 | 90 | 356.3 | 158.6 | 50 | 411.1 | 183.0 | 10 | 465.9 | 207.4 | 70 | 520.7 | 231.8 |
| 331 | 302.4 | 134.6 | 391 | 357.2 | 159.0 | 451 | 412.0 | 183.4 | 511 | 466.8 | 207.8 | 571 | 521.6 | 232.2 |
| 32 | 303.3 | 135.0 | 92 | 358.1 | 159.4 | 52 | 412.9 | 183.8 | 12 | 467.7 | 208.2 | 72 | 522.5 | 232.7 |
| 33 | 304.2 | 135.4 | 93 | 359.0 | 159.8 | 53 | 413.8 | 184.3 | 13 | 468.6 | 208.7 | 73 | 523.4 | 233.1 |
| 34 | 305.1 | 135.9 | 94 | 359.9 | 160.3 | 54 | 414.7 | 184.7 | 14 | 469.5 | 209.1 | 74 | 524.3 | 233.5 |
| 35 | 306.0 | 136.3 | 95 | 360.8 | 160.7 | 55 | 415.7 | 185.1 | 15 | 470.5 | 209.5 | 75 | 525.3 | 233.9 |
| 36 | 306.9 | 136.7 | 96 | 361.8 | 161.1 | 56 | 416.6 | 185.5 | 16 | 471.4 | 209.9 | 76 | 526.2 | 234.3 |
| 37 | 307.9 | 137.1 | 97 | 362.7 | 161.5 | 57 | 417.5 | 185.9 | 17 | 472.3 | 210.3 | 77 | 527.1 | 234.7 |
| 38 | 308.8 | 137.5 | 98 | 363.6 | 161.9 | 58 | 418.4 | 186.3 | 18 | 473.2 | 210.7 | 78 | 528.0 | 235.1 |
| 39 | 309.7 | 137.9 | 99 | 364.5 | 162.3 | 59 | 419.3 | 186.7 | 19 | 474.1 | 211.1 | 79 | 528.9 | 235.5 |
| 40 | 310.6 | 138.3 | 400 | 365.4 | 162.7 | 60 | 420.2 | 187.1 | 20 | 475.0 | 211.5 | 80 | 529.8 | 235.9 |
| 341 | 311.5 | 138.7 | 401 | 366.3 | 163.1 | 461 | 421.1 | 187.5 | 521 | 475.9 | 211.9 | 581 | 530.8 | 236.3 |
| 42 | 312.4 | 139.1 | 02 | 367.2 | 163.5 | 62 | 422.0 | 187.9 | 22 | 476.8 | 212.3 | 82 | 531.7 | 236.7 |
| 43 | 313.3 | 139.5 | 03 | 368.2 | 163.9 | 63 | 423.0 | 188.3 | 23 | 477.8 | 212.7 | 83 | 532.6 | 237.1 |
| 44 | 314.3 | 139.9 | 04 | 369.1 | 164.3 | 64 | 423.9 | 188.7 | 24 | 478.7 | 213.1 | 84 | 533.5 | 237.5 |
| 45 | 315.2 | 140.3 | 05 | 370.0 | 164.7 | 65 | 424.8 | 189.1 | 25 | 479.6 | 213.5 | 85 | 534.4 | 237.9 |
| 46 | 316.1 | 140.7 | 06 | 370.9 | 165.1 | 66 | 425.7 | 189.5 | 26 | 480.5 | 213.9 | 86 | 535.3 | 238.3 |
| 47 | 317.0 | 141.1 | 07 | 371.8 | 165.5 | 67 | 426.6 | 189.9 | 27 | 481.4 | 214.4 | 87 | 536.2 | 238.8 |
| 48 | 317.9 | 141.5 | 08 | 372.7 | 165.9 | 68 | 427.5 | 190.4 | 28 | 482.3 | 214.8 | 88 | 537.1 | 239.2 |
| 49 | 318.8 | 142.0 | 09 | 373.6 | 166.4 | 69 | 428.4 | 190.8 | 29 | 483.2 | 215.2 | 89 | 538.0 | 239.6 |
| 50 | 319.7 | 142.4 | 10 | 374.5 | 166.8 | 70 | 429.4 | 191.2 | 30 | 484.2 | 215.6 | 90 | 539.0 | 240.0 |
| 351 | 320.6 | 142.8 | 411 | 375.5 | 167.2 | 471 | 430.3 | 191.6 | 531 | 485.1 | 216.0 | 591 | 539.9 | 240.4 |
| 52 | 321.6 | 143.2 | 12 | 376.4 | 167.6 | 72 | 431.2 | 192.0 | 32 | 486.0 | 216.4 | 92 | 540.8 | 240.8 |
| 53 | 322.5 | 143.6 | 13 | 377.3 | 168.0 | 73 | 432.1 | 192.4 | 33 | 486.9 | 216.8 | 93 | 541.7 | 241.2 |
| 54 | 323.4 | 144.0 | 14 | 378.2 | 168.4 | 74 | 433.0 | 192.8 | 34 | 487.8 | 217.2 | 94 | 542.6 | 241.6 |
| 55 | 324.3 | 144.4 | 15 | 379.1 | 168.8 | 75 | 433.9 | 193.2 | 35 | 488.7 | 217.6 | 95 | 543.5 | 242.0 |
| 56 | 325.2 | 144.8 | 16 | 380.0 | 169.2 | 76 | 434.8 | 193.6 | 36 | 489.6 | 218.0 | 96 | 544.4 | 242.4 |
| 57 | 326.1 | 145.2 | 17 | 380.9 | 169.6 | 77 | 435.8 | 194.0 | 37 | 490.6 | 218.4 | 97 | 545.4 | 242.8 |
| 58 | 327.0 | 145.6 | 18 | 381.9 | 170.0 | 78 | 436.7 | 194.4 | 38 | 491.5 | 218.8 | 98 | 546.3 | 243.2 |
| 59 | 328.0 | 146.0 | 19 | 382.8 | 170.4 | 79 | 437.6 | 194.8 | 39 | 492.4 | 219.2 | 99 | 547.2 | 243.6 |
| 60 | 328.9 | 146.4 | 20 | 383.7 | 170.8 | 80 | 438.5 | 195.2 | 40 | 493.3 | 219.6 | 600 | 548.1 | 244.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

66° (114°, 246°, 294°).

# TABLE 2.

### Difference of Latitude and Departure for 25° (155°, 205°, 335°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 55.3 | 25.8 | 121 | 109.7 | 51.1 | 181 | 164.0 | 76.5 | 241 | 218.4 | 101.9 |
| 2 | 1.8 | 0.8 | 62 | 56.2 | 26.2 | 22 | 110.6 | 51.6 | 82 | 164.9 | 76.9 | 42 | 219.3 | 102.3 |
| 3 | 2.7 | 1.3 | 63 | 57.1 | 26.6 | 23 | 111.5 | 52.0 | 83 | 165.9 | 77.3 | 43 | 220.2 | 102.7 |
| 4 | 3.6 | 1.7 | 64 | 58.0 | 27.0 | 24 | 112.4 | 52.4 | 84 | 166.8 | 77.8 | 44 | 221.1 | 103.1 |
| 5 | 4.5 | 2.1 | 65 | 58.9 | 27.5 | 25 | 113.3 | 52.8 | 85 | 167.7 | 78.2 | 45 | 222.0 | 103.5 |
| 6 | 5.4 | 2.5 | 66 | 59.8 | 27.9 | 26 | 114.2 | 53.2 | 86 | 168.6 | 78.6 | 46 | 223.0 | 104.0 |
| 7 | 6.3 | 3.0 | 67 | 60.7 | 28.3 | 27 | 115.1 | 53.7 | 87 | 169.5 | 79.0 | 47 | 223.9 | 104.4 |
| 8 | 7.3 | 3.4 | 68 | 61.6 | 28.7 | 28 | 116.0 | 54.1 | 88 | 170.4 | 79.5 | 48 | 224.8 | 104.8 |
| 9 | 8.2 | 3.8 | 69 | 62.5 | 29.2 | 29 | 116.9 | 54.5 | 89 | 171.3 | 79.9 | 49 | 225.7 | 105.2 |
| 10 | 9.1 | 4.2 | 70 | 63.4 | 29.6 | 30 | 117.8 | 54.9 | 90 | 172.2 | 80.3 | 50 | 226.6 | 105.7 |
| 11 | 10.0 | 4.6 | 71 | 64.3 | 30.0 | 131 | 118.7 | 55.4 | 191 | 173.1 | 80.7 | 251 | 227.5 | 106.1 |
| 12 | 10.9 | 5.1 | 72 | 65.3 | 30.4 | 32 | 119.6 | 55.8 | 92 | 174.0 | 81.1 | 52 | 228.4 | 106.5 |
| 13 | 11.8 | 5.5 | 73 | 66.2 | 30.9 | 33 | 120.5 | 56.2 | 93 | 174.9 | 81.6 | 53 | 229.3 | 106.9 |
| 14 | 12.7 | 5.9 | 74 | 67.1 | 31.3 | 34 | 121.4 | 56.6 | 94 | 175.8 | 82.0 | 54 | 230.2 | 107.3 |
| 15 | 13.6 | 6.3 | 75 | 68.0 | 31.7 | 35 | 122.4 | 57.1 | 95 | 176.7 | 82.4 | 55 | 231.1 | 107.8 |
| 16 | 14.5 | 6.8 | 76 | 68.9 | 32.1 | 36 | 123.3 | 57.5 | 96 | 177.6 | 82.8 | 56 | 232.0 | 108.2 |
| 17 | 15.4 | 7.2 | 77 | 69.8 | 32.5 | 37 | 124.2 | 57.9 | 97 | 178.5 | 83.3 | 57 | 232.9 | 108.6 |
| 18 | 16.3 | 7.6 | 78 | 70.7 | 33.0 | 38 | 125.1 | 58.3 | 98 | 179.4 | 83.7 | 58 | 233.8 | 109.0 |
| 19 | 17.2 | 8.0 | 79 | 71.6 | 33.4 | 39 | 126.0 | 58.7 | 99 | 180.4 | 84.1 | 59 | 234.7 | 109.5 |
| 20 | 18.1 | 8.5 | 80 | 72.5 | 33.8 | 40 | 126.9 | 59.2 | 200 | 181.3 | 84.5 | 60 | 235.6 | 109.9 |
| 21 | 19.0 | 8.9 | 81 | 73.4 | 34.2 | 141 | 127.8 | 59.6 | 201 | 182.2 | 84.9 | 261 | 236.5 | 110.3 |
| 22 | 19.9 | 9.3 | 82 | 74.3 | 34.7 | 42 | 128.7 | 60.0 | 02 | 183.1 | 85.4 | 62 | 237.5 | 110.7 |
| 23 | 20.8 | 9.7 | 83 | 75.2 | 35.1 | 43 | 129.6 | 60.4 | 03 | 184.0 | 85.8 | 63 | 238.4 | 111.1 |
| 24 | 21.8 | 10.1 | 84 | 76.1 | 35.5 | 44 | 130.5 | 60.9 | 04 | 184.9 | 86.2 | 64 | 239.3 | 111.6 |
| 25 | 22.7 | 10.6 | 85 | 77.0 | 35.9 | 45 | 131.4 | 61.3 | 05 | 185.8 | 86.6 | 65 | 240.2 | 112.0 |
| 26 | 23.6 | 11.0 | 86 | 77.9 | 36.3 | 46 | 132.3 | 61.7 | 06 | 186.7 | 87.1 | 66 | 241.1 | 112.4 |
| 27 | 24.5 | 11.4 | 87 | 78.8 | 36.8 | 47 | 133.2 | 62.1 | 07 | 187.6 | 87.5 | 67 | 242.0 | 112.8 |
| 28 | 25.4 | 11.8 | 88 | 79.8 | 37.2 | 48 | 134.1 | 62.5 | 08 | 188.5 | 87.9 | 68 | 242.9 | 113.3 |
| 29 | 26.3 | 12.3 | 89 | 80.7 | 37.6 | 49 | 135.0 | 63.0 | 09 | 189.4 | 88.3 | 69 | 243.8 | 113.7 |
| 30 | 27.2 | 12.7 | 90 | 81.6 | 38.0 | 50 | 135.9 | 63.4 | 10 | 190.3 | 88.7 | 70 | 244.7 | 114.1 |
| 31 | 28.1 | 13.1 | 91 | 82.5 | 38.5 | 151 | 136.9 | 63.8 | 211 | 191.2 | 89.2 | 271 | 245.6 | 114.5 |
| 32 | 29.0 | 13.5 | 92 | 83.4 | 38.9 | 52 | 137.8 | 64.2 | 12 | 192.1 | 89.6 | 72 | 246.5 | 115.0 |
| 33 | 29.9 | 13.9 | 93 | 84.3 | 39.3 | 53 | 138.7 | 64.7 | 13 | 193.0 | 90.0 | 73 | 247.4 | 115.4 |
| 34 | 30.8 | 14.4 | 94 | 85.2 | 39.7 | 54 | 139.6 | 65.1 | 14 | 193.9 | 90.4 | 74 | 248.3 | 115.8 |
| 35 | 31.7 | 14.8 | 95 | 86.1 | 40.1 | 55 | 140.5 | 65.5 | 15 | 194.9 | 90.9 | 75 | 249.2 | 116.2 |
| 36 | 32.6 | 15.2 | 96 | 87.0 | 40.6 | 56 | 141.4 | 65.9 | 16 | 195.8 | 91.3 | 76 | 250.1 | 116.6 |
| 37 | 33.5 | 15.6 | 97 | 87.9 | 41.0 | 57 | 142.3 | 66.4 | 17 | 196.7 | 91.7 | 77 | 251.0 | 117.1 |
| 38 | 34.4 | 16.1 | 98 | 88.8 | 41.4 | 58 | 143.2 | 66.8 | 18 | 197.6 | 92.1 | 78 | 252.0 | 117.5 |
| 39 | 35.3 | 16.5 | 99 | 89.7 | 41.8 | 59 | 144.1 | 67.2 | 19 | 198.5 | 92.6 | 79 | 252.9 | 117.9 |
| 40 | 36.3 | 16.9 | 100 | 90.6 | 42.3 | 60 | 145.0 | 67.6 | 20 | 199.4 | 93.0 | 80 | 253.8 | 118.3 |
| 41 | 37.2 | 17.3 | 101 | 91.5 | 42.7 | 161 | 145.9 | 68.0 | 221 | 200.3 | 93.4 | 281 | 254.7 | 118.8 |
| 42 | 38.1 | 17.7 | 02 | 92.4 | 43.1 | 62 | 146.8 | 68.5 | 22 | 201.2 | 93.8 | 82 | 255.6 | 119.2 |
| 43 | 39.0 | 18.2 | 03 | 93.3 | 43.5 | 63 | 147.7 | 68.9 | 23 | 202.1 | 94.2 | 83 | 256.5 | 119.6 |
| 44 | 39.9 | 18.6 | 04 | 94.3 | 44.0 | 64 | 148.6 | 69.3 | 24 | 203.0 | 94.7 | 84 | 257.4 | 120.0 |
| 45 | 40.8 | 19.0 | 05 | 95.2 | 44.4 | 65 | 149.5 | 69.7 | 25 | 203.9 | 95.1 | 85 | 258.3 | 120.4 |
| 46 | 41.7 | 19.4 | 06 | 96.1 | 44.8 | 66 | 150.4 | 70.2 | 26 | 204.8 | 95.5 | 86 | 259.2 | 120.9 |
| 47 | 42.6 | 19.9 | 07 | 97.0 | 45.2 | 67 | 151.4 | 70.6 | 27 | 205.7 | 95.9 | 87 | 260.1 | 121.3 |
| 48 | 43.5 | 20.3 | 08 | 97.9 | 45.6 | 68 | 152.3 | 71.0 | 28 | 206.6 | 96.4 | 88 | 261.0 | 121.7 |
| 49 | 44.4 | 20.7 | 09 | 98.8 | 46.1 | 69 | 153.2 | 71.4 | 29 | 207.5 | 96.8 | 89 | 261.9 | 122.1 |
| 50 | 45.3 | 21.1 | 10 | 99.7 | 46.5 | 70 | 154.1 | 71.8 | 30 | 208.5 | 97.2 | 90 | 262.8 | 122.6 |
| 51 | 46.2 | 21.6 | 111 | 100.6 | 46.9 | 171 | 155.0 | 72.3 | 231 | 209.4 | 97.6 | 291 | 263.7 | 123.0 |
| 52 | 47.1 | 22.0 | 12 | 101.5 | 47.3 | 72 | 155.9 | 72.7 | 32 | 210.3 | 98.0 | 92 | 264.6 | 123.4 |
| 53 | 48.0 | 22.4 | 13 | 102.4 | 47.8 | 73 | 156.8 | 73.1 | 33 | 211.2 | 98.5 | 93 | 265.5 | 123.8 |
| 54 | 48.9 | 22.8 | 14 | 103.3 | 48.2 | 74 | 157.7 | 73.5 | 34 | 212.1 | 98.9 | 94 | 266.5 | 124.2 |
| 55 | 49.8 | 23.2 | 15 | 104.2 | 48.6 | 75 | 158.6 | 74.0 | 35 | 213.0 | 99.3 | 95 | 267.4 | 124.7 |
| 56 | 50.8 | 23.7 | 16 | 105.1 | 49.0 | 76 | 159.5 | 74.4 | 36 | 213.9 | 99.7 | 96 | 268.3 | 125.1 |
| 57 | 51.7 | 24.1 | 17 | 106.0 | 49.4 | 77 | 160.4 | 74.8 | 37 | 214.8 | 100.2 | 97 | 269.2 | 125.5 |
| 58 | 52.6 | 24.5 | 18 | 106.9 | 49.9 | 78 | 161.3 | 75.2 | 38 | 215.7 | 100.6 | 98 | 270.1 | 125.9 |
| 59 | 53.5 | 24.9 | 19 | 107.9 | 50.3 | 79 | 162.2 | 75.6 | 39 | 216.6 | 101.0 | 99 | 271.0 | 126.4 |
| 60 | 54.4 | 25.4 | 20 | 108.8 | 50.7 | 80 | 163.1 | 76.1 | 40 | 217.5 | 101.4 | 300 | 271.9 | 126.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 65° (115°, 245°, 295°).

TABLE 2. [Page 417

Difference of Latitude and Departure for 25° (155°, 205°, 335°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 272.8 | 127.2 | 361 | 327.1 | 152.5 | 421 | 381.5 | 177.9 | 481 | 435.9 | 203.3 | 541 | 490.3 | 228.6 |
| 02 | 273.7 | 127.6 | 62 | 328.0 | 153.0 | 22 | 382.4 | 178.3 | 82 | 436.8 | 203.7 | 42 | 491.2 | 229.0 |
| 03 | 274.6 | 128.0 | 63 | 329.0 | 153.4 | 23 | 383.3 | 178.7 | 83 | 437.7 | 204.1 | 43 | 492.1 | 229.4 |
| 04 | 275.5 | 128.4 | 64 | 329.9 | 153.8 | 24 | 384.2 | 179.2 | 84 | 438.6 | 204.5 | 44 | 493.0 | 229.9 |
| 05 | 276.4 | 128.9 | 65 | 330.8 | 154.2 | 25 | 385.1 | 179.6 | 85 | 439.5 | 204.9 | 45 | 493.9 | 230.3 |
| 06 | 277.3 | 129.3 | 66 | 331.7 | 154.6 | 26 | 386.0 | 180.0 | 86 | 440.4 | 205.4 | 46 | 494.8 | 230.7 |
| 07 | 278.2 | 129.7 | 67 | 332.6 | 155.1 | 27 | 387.0 | 180.4 | 87 | 441.3 | 205.8 | 47 | 495.7 | 231.1 |
| 08 | 279.1 | 130.1 | 68 | 333.5 | 155.5 | 28 | 387.9 | 180.9 | 88 | 442.2 | 206.2 | 48 | 496.6 | 231.6 |
| 09 | 280.0 | 130.6 | 69 | 334.4 | 155.9 | 29 | 388.8 | 181.3 | 89 | 443.1 | 206.6 | 49 | 497.5 | 232.0 |
| 10 | 280.9 | 131.0 | 70 | 335.3 | 156.3 | 30 | 389.7 | 181.7 | 90 | 444.0 | 207.1 | 50 | 498.4 | 232.4 |
| 311 | 281.8 | 131.4 | 371 | 336.2 | 156.8 | 431 | 390.6 | 182.1 | 491 | 444.9 | 207.5 | 551 | 499.3 | 232.8 |
| 12 | 282.7 | 131.8 | 72 | 337.1 | 157.2 | 32 | 391.5 | 182.5 | 92 | 445.9 | 207.9 | 52 | 500.2 | 233.2 |
| 13 | 283.6 | 132.2 | 73 | 338.0 | 157.6 | 33 | 392.4 | 183.0 | 93 | 446.8 | 208.3 | 53 | 501.1 | 233.7 |
| 14 | 284.5 | 132.7 | 74 | 338.9 | 158.0 | 34 | 393.3 | 183.4 | 94 | 447.7 | 208.7 | 54 | 502.0 | 234.1 |
| 15 | 285.4 | 133.1 | 75 | 339.8 | 158.5 | 35 | 394.2 | 183.8 | 95 | 448.6 | 209.1 | 55 | 503.0 | 234.5 |
| 16 | 286.4 | 133.5 | 76 | 340.7 | 158.9 | 36 | 395.1 | 184.2 | 96 | 449.5 | 209.6 | 56 | 503.9 | 235.0 |
| 17 | 287.3 | 133.9 | 77 | 341.6 | 159.3 | 37 | 396.0 | 184.7 | 97 | 450.4 | 210.0 | 57 | 504.8 | 235.4 |
| 18 | 288.2 | 134.4 | 78 | 342.5 | 159.7 | 38 | 396.9 | 185.1 | 98 | 451.3 | 210.4 | 58 | 505.7 | 235.8 |
| 19 | 289.1 | 134.8 | 79 | 343.5 | 160.1 | 39 | 397.8 | 185.5 | 99 | 452.2 | 210.9 | 59 | 506.6 | 236.2 |
| 20 | 290.0 | 135.2 | 80 | 344.4 | 160.6 | 40 | 398.7 | 185.9 | 500 | 453.1 | 211.3 | 60 | 507.5 | 236.6 |
| 321 | 290.9 | 135.6 | 381 | 345.3 | 161.0 | 441 | 399.6 | 186.3 | 501 | 454.0 | 211.7 | 561 | 508.4 | 237.1 |
| 22 | 291.8 | 136.1 | 82 | 346.2 | 161.4 | 42 | 400.6 | 186.8 | 02 | 454.9 | 212.1 | 62 | 509.3 | 237.5 |
| 23 | 292.7 | 136.5 | 83 | 347.1 | 161.8 | 43 | 401.5 | 187.2 | 03 | 455.8 | 212.5 | 63 | 510.2 | 237.9 |
| 24 | 293.6 | 136.9 | 84 | 348.0 | 162.3 | 44 | 402.4 | 187.6 | 04 | 456.7 | 213.0 | 64 | 511.1 | 238.3 |
| 25 | 294.5 | 137.3 | 85 | 348.9 | 162.7 | 45 | 403.3 | 188.0 | 05 | 457.7 | 213.4 | 65 | 512.0 | 238.7 |
| 26 | 295.4 | 137.7 | 86 | 349.8 | 163.1 | 46 | 404.2 | 188.5 | 06 | 458.6 | 213.8 | 66 | 512.9 | 239.2 |
| 27 | 296.3 | 138.2 | 87 | 350.7 | 163.5 | 47 | 405.1 | 188.9 | 07 | 459.5 | 214.2 | 67 | 513.8 | 239.6 |
| 28 | 297.2 | 138.6 | 88 | 351.6 | 163.9 | 48 | 406.0 | 189.3 | 08 | 460.4 | 214.7 | 68 | 514.8 | 240.1 |
| 29 | 298.1 | 139.0 | 89 | 352.5 | 164.4 | 49 | 406.9 | 189.7 | 09 | 461.3 | 215.1 | 69 | 515.7 | 240.5 |
| 30 | 299.0 | 139.4 | 90 | 353.4 | 164.8 | 50 | 407.8 | 190.1 | 10 | 462.2 | 215.5 | 70 | 516.6 | 240.9 |
| 331 | 300.0 | 139.9 | 391 | 354.3 | 165.2 | 451 | 408.7 | 190.6 | 511 | 463.1 | 215.9 | 571 | 517.5 | 241.3 |
| 32 | 300.9 | 140.3 | 92 | 355.2 | 165.6 | 52 | 409.6 | 191.0 | 12 | 464.0 | 216.4 | 72 | 518.4 | 241.7 |
| 33 | 301.8 | 140.7 | 93 | 356.1 | 166.1 | 53 | 410.5 | 191.4 | 13 | 464.9 | 216.8 | 73 | 519.3 | 242.1 |
| 34 | 302.7 | 141.1 | 94 | 357.0 | 166.5 | 54 | 411.4 | 191.8 | 14 | 465.8 | 217.2 | 74 | 520.2 | 242.6 |
| 35 | 303.6 | 141.5 | 95 | 358.0 | 166.9 | 55 | 412.3 | 192.3 | 15 | 466.7 | 217.7 | 75 | 521.1 | 243.0 |
| 36 | 304.5 | 142.0 | 96 | 358.9 | 167.3 | 56 | 413.2 | 192.7 | 16 | 467.6 | 218.1 | 76 | 522.0 | 243.4 |
| 37 | 305.4 | 142.4 | 97 | 359.8 | 167.7 | 57 | 414.1 | 193.1 | 17 | 468.5 | 218.5 | 77 | 522.9 | 243.8 |
| 38 | 306.3 | 142.8 | 98 | 360.7 | 168.2 | 58 | 415.1 | 193.5 | 18 | 469.4 | 218.9 | 78 | 523.8 | 244.3 |
| 39 | 307.2 | 143.2 | 99 | 361.6 | 168.6 | 59 | 416.0 | 194.0 | 19 | 470.3 | 219.3 | 79 | 524.7 | 244.7 |
| 40 | 308.1 | 143.7 | 400 | 362.5 | 169.0 | 60 | 416.9 | 194.4 | 20 | 471.2 | 219.8 | 80 | 525.6 | 245.1 |
| 341 | 309.0 | 144.1 | 401 | 363.4 | 169.4 | 461 | 417.8 | 194.8 | 521 | 472.2 | 220.2 | 581 | 526.5 | 245.5 |
| 42 | 309.9 | 144.5 | 02 | 364.3 | 169.9 | 62 | 418.7 | 195.2 | 22 | 473.1 | 220.6 | 82 | 527.4 | 246.0 |
| 43 | 310.8 | 144.9 | 03 | 365.2 | 170.3 | 63 | 419.6 | 195.6 | 23 | 474.0 | 221.0 | 83 | 528.3 | 246.4 |
| 44 | 311.7 | 145.4 | 04 | 366.1 | 170.7 | 64 | 420.5 | 196.1 | 24 | 474.9 | 221.4 | 84 | 529.3 | 246.8 |
| 45 | 312.6 | 145.8 | 05 | 367.0 | 171.1 | 65 | 421.4 | 196.5 | 25 | 475.8 | 221.9 | 85 | 530.2 | 247.2 |
| 46 | 313.5 | 146.2 | 06 | 367.9 | 171.6 | 66 | 422.3 | 196.9 | 26 | 476.7 | 222.3 | 86 | 531.1 | 247.7 |
| 47 | 314.5 | 146.6 | 07 | 368.8 | 172.0 | 67 | 423.2 | 197.3 | 27 | 477.6 | 222.7 | 87 | 532.0 | 248.1 |
| 48 | 315.4 | 147.0 | 08 | 369.7 | 172.4 | 68 | 424.1 | 197.8 | 28 | 478.5 | 223.2 | 88 | 532.9 | 248.5 |
| 49 | 316.3 | 147.5 | 09 | 370.6 | 172.8 | 69 | 425.0 | 198.2 | 29 | 479.4 | 223.6 | 89 | 533.8 | 248.9 |
| 50 | 317.2 | 147.9 | 10 | 371.5 | 173.2 | 70 | 425.9 | 198.6 | 30 | 480.3 | 224.0 | 90 | 534.7 | 249.4 |
| 351 | 318.1 | 148.3 | 411 | 372.5 | 173.7 | 471 | 426.8 | 199.0 | 531 | 481.2 | 224.4 | 591 | 535.6 | 249.8 |
| 52 | 319.0 | 148.7 | 12 | 373.4 | 174.1 | 72 | 427.7 | 199.4 | 32 | 482.1 | 224.8 | 92 | 536.5 | 250.2 |
| 53 | 319.9 | 149.2 | 13 | 374.3 | 174.5 | 73 | 428.6 | 199.9 | 33 | 483.0 | 225.3 | 93 | 537.4 | 250.6 |
| 54 | 320.8 | 149.6 | 14 | 375.2 | 174.9 | 74 | 429.6 | 200.3 | 34 | 483.9 | 225.7 | 94 | 538.3 | 251.1 |
| 55 | 321.7 | 150.0 | 15 | 376.1 | 175.4 | 75 | 430.5 | 200.7 | 35 | 484.8 | 226.1 | 95 | 539.2 | 251.5 |
| 56 | 322.6 | 150.4 | 16 | 377.0 | 175.8 | 76 | 431.4 | 201.1 | 36 | 485.7 | 226.5 | 96 | 540.1 | 251.9 |
| 57 | 323.5 | 150.8 | 17 | 377.9 | 176.2 | 77 | 432.3 | 201.6 | 37 | 486.7 | 226.9 | 97 | 541.0 | 252.3 |
| 58 | 324.4 | 151.3 | 18 | 378.8 | 176.6 | 78 | 433.2 | 202.0 | 38 | 487.6 | 227.4 | 98 | 541.9 | 252.7 |
| 59 | 325.3 | 151.7 | 19 | 379.7 | 177.0 | 79 | 434.1 | 202.4 | 39 | 488.5 | 227.8 | 99 | 542.8 | 253.1 |
| 60 | 326.2 | 152.1 | 20 | 380.6 | 177.5 | 80 | 435.0 | 202.8 | 40 | 489.4 | 228.2 | 600 | 543.8 | 253.6 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

65° (115°, 245°, 295°).

# TABLE 2.

Difference of Latitude and Departure for 26° (154°, 206°, 334°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dêp. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.4 | 61 | 54.8 | 26.7 | 121 | 108.8 | 53.0 | 181 | 162.7 | 79.3 | 241 | 216.6 | 105.6 |
| 2 | 1.8 | 0.9 | 62 | 55.7 | 27.2 | 22 | 109.7 | 53.5 | 82 | 163.6 | 79.8 | 42 | 217.5 | 106.1 |
| 3 | 2.7 | 1.3 | 63 | 56.6 | 27.6 | 23 | 110.6 | 53.9 | 83 | 164.5 | 80.2 | 43 | 218.4 | 106.5 |
| 4 | 3.6 | 1.8 | 64 | 57.5 | 28.1 | 24 | 111.5 | 54.4 | 84 | 165.4 | 80.7 | 44 | 219.3 | 107.0 |
| 5 | 4.5 | 2.2 | 65 | 58.4 | 28.5 | 25 | 112.3 | 54.8 | 85 | 166.3 | 81.1 | 45 | 220.2 | 107.4 |
| 6 | 5.4 | 2.6 | 66 | 59.3 | 28.9 | 26 | 113.2 | 55.2 | 86 | 167.2 | 81.5 | 46 | 221.1 | 107.8 |
| 7 | 6.3 | 3.1 | 67 | 60.2 | 29.4 | 27 | 114.1 | 55.7 | 87 | 168.1 | 82.0 | 47 | 222.0 | 108.3 |
| 8 | 7.2 | 3.5 | 68 | 61.1 | 29.8 | 28 | 115.0 | 56.1 | 88 | 169.0 | 82.4 | 48 | 222.9 | 108.7 |
| 9 | 8.1 | 3.9 | 69 | 62.0 | 30.2 | 29 | 115.9 | 56.5 | 89 | 169.9 | 82.9 | 49 | 223.8 | 109.2 |
| 10 | 9.0 | 4.4 | 70 | 62.9 | 30.7 | 30 | 116.8 | 57.0 | 90 | 170.8 | 83.3 | 50 | 224.7 | 109.6 |
| 11 | 9.9 | 4.8 | 71 | 63.8 | 31.1 | 131 | 117.7 | 57.4 | 191 | 171.7 | 83.7 | 251 | 225.6 | 110.0 |
| 12 | 10.8 | 5.3 | 72 | 64.7 | 31.6 | 32 | 118.6 | 57.9 | 92 | 172.6 | 84.2 | 52 | 226.5 | 110.5 |
| 13 | 11.7 | 5.7 | 73 | 65.6 | 32.0 | 33 | 119.5 | 58.3 | 93 | 173.5 | 84.6 | 53 | 227.4 | 110.9 |
| 14 | 12.6 | 6.1 | 74 | 66.5 | 32.4 | 34 | 120.4 | 58.7 | 94 | 174.4 | 85.0 | 54 | 228.3 | 111.3 |
| 15 | 13.5 | 6.6 | 75 | 67.4 | 32.9 | 35 | 121.3 | 59.2 | 95 | 175.3 | 85.5 | 55 | 229.2 | 111.8 |
| 16 | 14.4 | 7.0 | 76 | 68.3 | 33.3 | 36 | 122.2 | 59.6 | 96 | 176.2 | 85.9 | 56 | 230.1 | 112.2 |
| 17 | 15.3 | 7.5 | 77 | 69.2 | 33.8 | 37 | 123.1 | 60.1 | 97 | 177.1 | 86.4 | 57 | 231.0 | 112.7 |
| 18 | 16.2 | 7.9 | 78 | 70.1 | 34.2 | 38 | 124.0 | 60.5 | 98 | 178.0 | 86.8 | 58 | 231.9 | 113.1 |
| 19 | 17.1 | 8.3 | 79 | 71.0 | 34.6 | 39 | 124.9 | 60.9 | 99 | 178.9 | 87.2 | 59 | 232.8 | 113.5 |
| 20 | 18.0 | 8.8 | 80 | 71.9 | 35.1 | 40 | 125.8 | 61.4 | 200 | 179.8 | 87.7 | 60 | 233.7 | 114.0 |
| 21 | 18.9 | 9.2 | 81 | 72.8 | 35.5 | 141 | 126.7 | 61.8 | 201 | 180.7 | 88.1 | 261 | 234.6 | 114.4 |
| 22 | 19.8 | 9.6 | 82 | 73.7 | 35.9 | 42 | 127.6 | 62.2 | 02 | 181.6 | 88.6 | 62 | 235.5 | 114.9 |
| 23 | 20.7 | 10.1 | 83 | 74.6 | 36.4 | 43 | 128.5 | 62.7 | 03 | 182.5 | 89.0 | 63 | 236.4 | 115.3 |
| 24 | 21.6 | 10.5 | 84 | 75.5 | 36.8 | 44 | 129.4 | 63.1 | 04 | 183.4 | 89.4 | 64 | 237.3 | 115.7 |
| 25 | 22.5 | 11.0 | 85 | 76.4 | 37.3 | 45 | 130.3 | 63.6 | 05 | 184.3 | 89.9 | 65 | 238.2 | 116.2 |
| 26 | 23.4 | 11.4 | 86 | 77.3 | 37.7 | 46 | 131.2 | 64.0 | 06 | 185.2 | 90.3 | 66 | 239.1 | 116.6 |
| 27 | 24.3 | 11.8 | 87 | 78.2 | 38.1 | 47 | 132.1 | 64.4 | 07 | 186.1 | 90.7 | 67 | 240.0 | 117.0 |
| 28 | 25.2 | 12.3 | 88 | 79.1 | 38.6 | 48 | 133.0 | 64.9 | 08 | 186.9 | 91.2 | 68 | 240.9 | 117.5 |
| 29 | 26.1 | 12.7 | 89 | 80.0 | 39.0 | 49 | 133.9 | 65.3 | 09 | 187.8 | 91.6 | 69 | 241.8 | 117.9 |
| 30 | 27.0 | 13.2 | 90 | 80.9 | 39.5 | 50 | 134.8 | 65.8 | 10 | 188.7 | 92.1 | 70 | 242.7 | 118.4 |
| 31 | 27.9 | 13.6 | 91 | 81.8 | 39.9 | 151 | 135.7 | 66.2 | 211 | 189.6 | 92.5 | 271 | 243.6 | 118.8 |
| 32 | 28.8 | 14.0 | 92 | 82.7 | 40.3 | 52 | 136.6 | 66.6 | 12 | 190.5 | 92.9 | 72 | 244.5 | 119.2 |
| 33 | 29.7 | 14.5 | 93 | 83.6 | 40.8 | 53 | 137.5 | 67.1 | 13 | 191.4 | 93.4 | 73 | 245.4 | 119.7 |
| 34 | 30.6 | 14.9 | 94 | 84.5 | 41.2 | 54 | 138.4 | 67.5 | 14 | 192.3 | 93.8 | 74 | 246.3 | 120.1 |
| 35 | 31.5 | 15.3 | 95 | 85.4 | 41.6 | 55 | 139.3 | 67.9 | 15 | 193.2 | 94.2 | 75 | 247.2 | 120.6 |
| 36 | 32.4 | 15.8 | 96 | 86.3 | 42.1 | 56 | 140.2 | 68.4 | 16 | 194.1 | 94.7 | 76 | 248.1 | 121.0 |
| 37 | 33.3 | 16.2 | 97 | 87.2 | 42.5 | 57 | 141.1 | 68.8 | 17 | 195.0 | 95.1 | 77 | 249.0 | 121.4 |
| 38 | 34.2 | 16.7 | 98 | 88.1 | 43.0 | 58 | 142.0 | 69.3 | 18 | 195.9 | 95.6 | 78 | 249.9 | 121.9 |
| 39 | 35.1 | 17.1 | 99 | 89.0 | 43.4 | 59 | 142.9 | 69.7 | 19 | 196.8 | 96.0 | 79 | 250.8 | 122.3 |
| 40 | 36.0 | 17.5 | 100 | 89.9 | 43.8 | 60 | 143.8 | 70.1 | 20 | 197.7 | 96.4 | 80 | 251.7 | 122.7 |
| 41 | 36.9 | 18.0 | 101 | 90.8 | 44.3 | 161 | 144.7 | 70.6 | 221 | 198.6 | 96.9 | 281 | 252.6 | 123.2 |
| 42 | 37.7 | 18.4 | 02 | 91.7 | 44.7 | 62 | 145.6 | 71.0 | 22 | 199.5 | 97.3 | 82 | 253.5 | 123.6 |
| 43 | 38.6 | 18.8 | 03 | 92.6 | 45.2 | 63 | 146.5 | 71.5 | 23 | 200.4 | 97.8 | 83 | 254.4 | 124.1 |
| 44 | 39.5 | 19.3 | 04 | 93.5 | 45.6 | 64 | 147.4 | 71.9 | 24 | 201.3 | 98.2 | 84 | 255.3' | 124.5 |
| 45 | 40.4 | 19.7 | 05 | 94.4 | 46.0 | 65 | 148.3 | 72.3 | 25 | 202.2 | 98.6 | 85 | 256.2 | 124.9 |
| 46 | 41.3 | 20.2 | 06 | 95.3 | 46.5 | 66 | 149.2 | 72.8 | 26 | 203.1 | 99.1 | 86 | 257.1 | 125.4 |
| 47 | 42.2 | 20.6 | 07 | 96.2 | 46.9 | 67 | 150.1 | 73.2 | 27 | 204.0 | 99.5 | 87 | 258.0 | 125.8 |
| 48 | 43.1 | 21.0 | 08 | 97.1 | 47.3 | 68 | 151.0 | 73.6 | 28 | 204.9 | 99.9 | 88 | 258.9 | 126.3 |
| 49 | 44.0 | 21.5 | 09 | 98.0 | 47.8 | 69 | 151.9 | 74.1 | 29 | 205.8 | 100.4 | 89 | 259.8 | 126.7 |
| 50 | 44.9 | 21.9 | 10 | 98.9 | 48.2 | 70 | 152.8 | 74.5 | 30 | 206.7 | 100.8 | 90 | 260.7 | 127.1 |
| 51 | 45.8 | 22.4 | 111 | 99.8 | 48.7 | 171 | 153.7 | 75.0 | 231 | 207.6 | 101.3 | 291 | 261.5 | 127.6 |
| 52 | 46.7 | 22.8 | 12 | 100.7 | 49.1 | 72 | 154.6 | 75.4 | 32 | 208.5 | 101.7 | 92 | 262.4 | 128.0 |
| 53 | 47.6 | 23.2 | 13 | 101.6 | 49.5 | 73 | 155.5 | 75.8 | 33 | 209.4 | 102.1 | 93 | 263.3 | 128.4 |
| 54 | 48.5 | 23.7 | 14 | 102.5 | 50.0 | 74 | 156.4 | 76.3 | 34 | 210.3 | 102.6 | 94 | 264.2 | 128.9 |
| 55 | 49.4 | 24.1 | 15 | 103.4 | 50.4 | 75 | 157.3 | 76.7 | 35 | 211.2 | 103.0 | 95 | 265.1 | 129.3 |
| 56 | 50.3 | 24.5 | 16 | 104.3 | 50.9 | 76 | 158.2 | 77.2 | 36 | 212.1 | 103.5 | 96 | 266.0 | 129.8 |
| 57 | 51.2 | 25.0 | 17 | 105.2 | 51.3 | 77 | 159.1 | 77.6 | 37 | 213.0 | 103.9 | 97 | 266.9 | 130.2 |
| 58 | 52.1 | 25.4 | 18 | 106.1 | 51.7 | 78 | 160.0 | 78.0 | 38 | 213.9 | 104.3 | 98 | 267.8 | 130.6 |
| 59 | 53.0 | 25.9 | 19 | 107.0 | 52.2 | 79 | 160.9 | 78.5 | 39 | 214.8 | 104.8 | 99 | 268.7 | 131.1 |
| 60 | 53.9 | 26.3 | 20 | 107.9 | 52.6 | 80 | 161.8 | 78.9 | 40 | 215.7 | 105.2 | 300 | 269.6 | 131.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

64° (116°, 244°, 296°).

TABLE 2.      [Page 419

Difference of Latitude and Departure for 26° (154°, 206°, 334°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 270.5 | 132.0 | 361 | 324.5 | 158.3 | 421 | 378.4 | 184.6 | 481 | 432.3 | 210.9 | 541 | 486.2 | 237.2 |
| 02 | 271.4 | 132.4 | 62 | 325.4 | 158.7 | 22 | 379.3 | 185.0 | 82 | 433.2 | 211.3 | 42 | 487.1 | 237.6 |
| 03 | 272.3 | 132.8 | 63 | 326.3 | 159.1 | 23 | 380.2 | 185.4 | 83 | 434.1 | 211.7 | 43 | 488.0 | 238.0 |
| 04 | 273.2 | 133.3 | 64 | 327.2 | 159.6 | 24 | 381.1 | 185.9 | 84 | 435.0 | 212.2 | 44 | 488.9 | 238.5 |
| 05 | 274.1 | 133.7 | 65 | 328.1 | 160.0 | 25 | 382.0 | 186.3 | 85 | 435.9 | 212.6 | 45 | 489.8 | 238.9 |
| 06 | 275.0 | 134.1 | 66 | 329.0 | 160.4 | 26 | 382.9 | 186.7 | 86 | 436.8 | 213.0 | 46 | 490.7 | 239.3 |
| 07 | 275.9 | 134.6 | 67 | 329.9 | 160.9 | 27 | 383.8 | 187.2 | 87 | 437.7 | 213.5 | 47 | 491.6 | 239.8 |
| 08 | 276.8 | 135.0 | 68 | 330.8 | 161.3 | 28 | 384.7 | 187.6 | 88 | 438.6 | 213.9 | 48 | 492.5 | 240.2 |
| 09 | 277.7 | 135.5 | 69 | 331.7 | 161.8 | 29 | 385.6 | 188.1 | 89 | 439.5 | 214.4 | 49 | 493.4 | 240.7 |
| 10 | 278.6 | 135.9 | 70 | 332.6 | 162.2 | 30 | 386.5 | 188.5 | 90 | 440.4 | 214.8 | 50 | 494.3 | 241.1 |
| 311 | 279.5 | 136.3 | 371 | 333.5 | 162.6 | 431 | 387.4 | 188.9 | 491 | 441.3 | 215.2 | 551 | 495.2 | 241.5 |
| 12 | 280.4 | 136.8 | 72 | 334.4 | 163.1 | 32 | 388.3 | 189.4 | 92 | 442.2 | 215.7 | 52 | 496.1 | 242.0 |
| 13 | 281.3 | 137.2 | 73 | 335.3 | 163.5 | 33 | 389.2 | 189.8 | 93 | 443.1 | 216.1 | 53 | 497.0 | 242.4 |
| 14 | 282.2 | 137.7 | 74 | 336.2 | 164.0 | 34 | 390.1 | 190.3 | 94 | 444.0 | 216.6 | 54 | 497.9 | 242.9 |
| 15 | 283.1 | 138.1 | 75 | 337.1 | 164.4 | 35 | 391.0 | 190.7 | 95 | 444.9 | 217.0 | 55 | 498.8 | 243.3 |
| 16 | 284.0 | 138.5 | 76 | 338.0 | 164.8 | 36 | 391.9 | 191.1 | 96 | 445.8 | 217.4 | 56 | 499.7 | 243.7 |
| 17 | 284.9 | 139.0 | 77 | 338.9 | 165.3 | 37 | 392.8 | 191.6 | 97 | 446.7 | 217.9 | 57 | 500.6 | 244.2 |
| 18 | 285.8 | 139.4 | 78 | 339.8 | 165.7 | 38 | 393.7 | 192.0 | 98 | 447.6 | 218.3 | 58 | 501.5 | 244.6 |
| 19 | 286.7 | 139.8 | 79 | 340.7 | 166.2 | 39 | 394.6 | 192.4 | 99 | 448.5 | 218.7 | 59 | 502.4 | 245.0 |
| 20 | 287.6 | 140.3 | 80 | 341.5 | 166.6 | 40 | 395.5 | 192.9 | 500 | 449.4 | 219.2 | 60 | 503.3 | 245.5 |
| 321 | 288.5 | 140.7 | 381 | 342.4 | 167.0 | 441 | 396.4 | 193.3 | 501 | 450.3 | 219.6 | 561 | 504.2 | 245.9 |
| 22 | 289.4 | 141.2 | 82 | 343.3 | 167.5 | 42 | 397.3 | 193.8 | 02 | 451.2 | 220.1 | 62 | 505.1 | 246.4 |
| 23 | 290.3 | 141.6 | 83 | 344.2 | 167.9 | 43 | 398.2 | 194.2 | 03 | 452.1 | 220.5 | 63 | 506.0 | 246.8 |
| 24 | 291.2 | 142.0 | 84 | 345.1 | 168.3 | 44 | 399.1 | 194.7 | 04 | 453.0 | 221.0 | 64 | 506.9 | 247.3 |
| 25 | 292.1 | 142.5 | 85 | 346.0 | 168.8 | 45 | 400.0 | 195.1 | 05 | 453.9 | 221.4 | 65 | 507.8 | 247.7 |
| 26 | 293.0 | 142.9 | 86 | 346.9 | 169.2 | 46 | 400.9 | 195.5 | 06 | 454.8 | 221.8 | 66 | 508.7 | 248.1 |
| 27 | 293.9 | 143.4 | 87 | 347.8 | 169.7 | 47 | 401.8 | 196.0 | 07 | 455.7 | 222.3 | 67 | 509.6 | 248.6 |
| 28 | 294.8 | 143.8 | 88 | 348.7 | 170.1 | 48 | 402.7 | 196.4 | 08 | 456.6 | 222.7 | 68 | 510.5 | 249.0 |
| 29 | 295.7 | 144.2 | 89 | 349.6 | 170.5 | 49 | 403.6 | 196.8 | 09 | 457.5 | 223.1 | 69 | 511.4 | 249.4 |
| 30 | 296.6 | 144.7 | 90 | 350.5 | 171.0 | 50 | 404.5 | 197.3 | 10 | 458.4 | 223.6 | 70 | 512.3 | 249.9 |
| 331 | 297.5 | 145.1 | 391 | 351.4 | 171.4 | 451 | 405.4 | 197.7 | 511 | 459.3 | 224.0 | 571 | 513.2 | 250.3 |
| 32 | 298.4 | 145.6 | 92 | 352.3 | 171.8 | 52 | 406.3 | 198.1 | 12 | 460.2 | 224.4 | 72 | 514.1 | 250.8 |
| 33 | 299.3 | 146.0 | 93 | 353.2 | 172.3 | 53 | 407.2 | 198.6 | 13 | 461.1 | 224.9 | 73 | 515.0 | 251.2 |
| 34 | 300.2 | 146.4 | 94 | 354.1 | 172.7 | 54 | 408.1 | 199.0 | 14 | 462.0 | 225.3 | 74 | 515.9 | 251.6 |
| 35 | 301.1 | 146.9 | 95 | 355.0 | 173.2 | 55 | 409.0 | 199.5 | 15 | 462.9 | 225.8 | 75 | 516.8 | 252.1 |
| 36 | 302.0 | 147.3 | 96 | 355.9 | 173.6 | 56 | 409.9 | 199.9 | 16 | 463.8 | 226.2 | 76 | 517.7 | 252.5 |
| 37 | 302.9 | 147.7 | 97 | 356.8 | 174.0 | 57 | 410.8 | 200.3 | 17 | 464.7 | 226.6 | 77 | 518.6 | 252.9 |
| 38 | 303.8 | 148.2 | 98 | 357.7 | 174.5 | 58 | 411.7 | 200.8 | 18 | 465.6 | 227.1 | 78 | 519.5 | 253.4 |
| 39 | 304.7 | 148.6 | 99 | 358.6 | 174.9 | 59 | 412.6 | 201.2 | 19 | 466.5 | 227.5 | 79 | 520.4 | 253.8 |
| 40 | 305.6 | 149.0 | 400 | 359.5 | 175.4 | 60 | 413.5 | 201.7 | 20 | 467.4 | 228.0 | 80 | 521.3 | 254.3 |
| 341 | 306.5 | 149.5 | 401 | 360.4 | 175.8 | 461 | 414.4 | 202.1 | 521 | 468.3 | 228.4 | 581 | 522.2 | 254.7 |
| 42 | 307.4 | 149.9 | 02 | 361.3 | 176.2 | 62 | 415.2 | 202.5 | 22 | 469.2 | 228.8 | 82 | 523.1 | 255.1 |
| 43 | 308.3 | 150.4 | 03 | 362.2 | 176.7 | 63 | 416.1 | 203.0 | 23 | 470.1 | 229.3 | 83 | 524.0 | 255.6 |
| 44 | 309.2 | 150.8 | 04 | 363.1 | 177.1 | 64 | 417.0 | 203.4 | 24 | 471.0 | 229.7 | 84 | 524.9 | 256.0 |
| 45 | 310.1 | 151.2 | 05 | 364.0 | 177.5 | 65 | 417.9 | 203.8 | 25 | 471.9 | 230.1 | 85 | 525.8 | 256.4 |
| 46 | 311.0 | 151.7 | 06 | 364.9 | 178.0 | 66 | 418.8 | 204.3 | 26 | 472.8 | 230.6 | 86 | 526.7 | 256.9 |
| 47 | 311.9 | 152.1 | 07 | 365.8 | 178.4 | 67 | 419.7 | 204.7 | 27 | 473.7 | 231.0 | 87 | 527.6 | 257.3 |
| 48 | 312.8 | 152.6 | 08 | 366.7 | 178.9 | 68 | 420.6 | 205.2 | 28 | 474.6 | 231.5 | 88 | 528.5 | 257.8 |
| 49 | 313.7 | 153.0 | 09 | 367.6 | 179.3 | 69 | 421.5 | 205.6 | 29 | 475.5 | 231.9 | 89 | 529.4 | 258.2 |
| 50 | 314.6 | 153.4 | 10 | 368.5 | 179.7 | 70 | 422.4 | 206.0 | 30 | 476.4 | 232.3 | 90 | 530.3 | 258.6 |
| 351 | 315.5 | 153.9 | 411 | 369.4 | 180.2 | 471 | 423.3 | 206.5 | 531 | 477.3 | 232.8 | 591 | 531.2 | 259.1 |
| 52 | 316.4 | 154.3 | 12 | 370.3 | 180.6 | 72 | 424.2 | 206.9 | 32 | 478.2 | 233.2 | 92 | 532.1 | 259.5 |
| 53 | 317.3 | 154.7 | 13 | 371.2 | 181.1 | 73 | 425.1 | 207.3 | 33 | 479.1 | 233.6 | 93 | 533.0 | 259.9 |
| 54 | 318.2 | 155.2 | 14 | 372.1 | 181.5 | 74 | 426.0 | 207.8 | 34 | 480.0 | 234.1 | 94 | 533.9 | 260.4 |
| 55 | 319.1 | 155.6 | 15 | 373.0 | 181.9 | 75 | 426.9 | 208.2 | 35 | 480.9 | 234.5 | 95 | 534.8 | 260.8 |
| 56 | 320.0 | 156.1 | 16 | 373.9 | 182.4 | 76 | 427.8 | 208.7 | 36 | 481.8 | 235.0 | 96 | 535.7 | 261.3 |
| 57 | 320.9 | 156.5 | 17 | 374.8 | 182.8 | 77 | 428.7 | 209.1 | 37 | 482.7 | 235.4 | 97 | 536.6 | 261.7 |
| 58 | 321.8 | 156.9 | 18 | 375.7 | 183.2 | 78 | 429.6 | 209.5 | 38 | 483.6 | 235.8 | 98 | 537.5 | 262.1 |
| 59 | 322.7 | 157.4 | 19 | 376.6 | 183.7 | 79 | 430.5 | 210.0 | 39 | 484.5 | 236.3 | 90 | 538.4 | 262.6 |
| 60 | 323.6 | 157.8 | 20 | 377.5 | 184.1 | 80 | 431.4 | 210.4 | 40 | 485.3 | 236.7 | 600 | 539.3 | 263.0 |

| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

64° (116°, 244°, 296°).

# TABLE 2.

### Difference of Latitude and Departure for 27° (153°, 207°, 333°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.5 | 61 | 54.4 | 27.7 | 121 | 107.8 | 54.9 | 181 | 161.3 | 82.2 | 241 | 214.7 | 109.4 |
| 2 | 1.8 | 0.9 | 62 | 55.2 | 28.1 | 22 | 108.7 | 55.4 | 82 | 162.2 | 82.6 | 42 | 215.6 | 109.9 |
| 3 | 2.7 | 1.4 | 63 | 56.1 | 28.6 | 23 | 109.6 | 55.8 | 83 | 163.1 | 83.1 | 43 | 216.5 | 110.3 |
| 4 | 3.6 | 1.8 | 64 | 57.0 | 29.1 | 24 | 110.5 | 56.3 | 84 | 163.9 | 83.5 | 44 | 217.4 | 110.8 |
| 5 | 4.5 | 2.3 | 65 | 57.9 | 29.5 | 25 | 111.4 | 56.7 | 85 | 164.8 | 84.0 | 45 | 218.3 | 111.2 |
| 6 | 5.3 | 2.7 | 66 | 58.8 | 30.0 | 26 | 112.3 | 57.2 | 86 | 165.7 | 84.4 | 46 | 219.2 | 111.7 |
| 7 | 6.2 | 3.2 | 67 | 59.7 | 30.4 | 27 | 113.2 | 57.7 | 87 | 166.6 | 84.9 | 47 | 220.1 | 112.1 |
| 8 | 7.1 | 3.6 | 68 | 60.6 | 30.9 | 28 | 114.0 | 58.1 | 88 | 167.5 | 85.4 | 48 | 221.0 | 112.6 |
| 9 | 8.0 | 4.1 | 69 | 61.5 | 31.3 | 29 | 114.9 | 58.6 | 89 | 168.4 | 85.8 | 49 | 221.9 | 113.0 |
| 10 | 8.9 | 4.5 | 70 | 62.4 | 31.8 | 30 | 115.8 | 59.0 | 90 | 169.3 | 86.3 | 50 | 222.8 | 113.5 |
| 11 | 9.8 | 5.0 | 71 | 63.3 | 32.2 | 131 | 116.7 | 59.5 | 191 | 170.2 | 86.7 | 251 | 223.6 | 114.0 |
| 12 | 10.7 | 5.4 | 72 | 64.2 | 32.7 | 32 | 117.6 | 59.9 | 92 | 171.1 | 87.2 | 52 | 224.5 | 114.4 |
| 13 | 11.6 | 5.9 | 73 | 65.0 | 33.1 | 33 | 118.5 | 60.4 | 93 | 172.0 | 87.6 | 53 | 225.4 | 114.9 |
| 14 | 12.5 | 6.4 | 74 | 65.9 | 33.6 | 34 | 119.4 | 60.8 | 94 | 172.9 | 88.1 | 54 | 226.3 | 115.3 |
| 15 | 13.4 | 6.8 | 75 | 66.8 | 34.0 | 35 | 120.3 | 61.3 | 95 | 173.7 | 88.5 | 55 | 227.2 | 115.8 |
| 16 | 14.3 | 7.3 | 76 | 67.7 | 34.5 | 36 | 121.2 | 61.7 | 96 | 174.6 | 89.0 | 56 | 228.1 | 116.2 |
| 17 | 15.1 | 7.7 | 77 | 68.6 | 35.0 | 37 | 122.1 | 62.2 | 97 | 175.5 | 89.4 | 57 | 229.0 | 116.7 |
| 18 | 16.0 | 8.2 | 78 | 69.5 | 35.4 | 38 | 123.0 | 62.7 | 98 | 176.4 | 89.9 | 58 | 229.9 | 117.1 |
| 19 | 16.9 | 8.6 | 79 | 70.4 | 35.9 | 39 | 123.8 | 63.1 | 99 | 177.3 | 90.3 | 59 | 230.8 | 117.6 |
| 20 | 17.8 | 9.1 | 80 | 71.3 | 36.3 | 40 | 124.7 | 63.6 | 200 | 178.2 | 90.8 | 60 | 231.7 | 118.0 |
| 21 | 18.7 | 9.5 | 81 | 72.2 | 36.8 | 141 | 125.6 | 64.0 | 201 | 179.1 | 91.3 | 261 | 232.6 | 118.5 |
| 22 | 19.6 | 10.0 | 82 | 73.1 | 37.2 | 42 | 126.5 | 64.5 | 02 | 180.0 | 91.7 | 62 | 233.4 | 118.9 |
| 23 | 20.5 | 10.4 | 83 | 74.0 | 37.7 | 43 | 127.4 | 64.9 | 03 | 180.9 | 92.2 | 63 | 234.3 | 119.4 |
| 24 | 21.4 | 10.9 | 84 | 74.8 | 38.1 | 44 | 128.3 | 65.4 | 04 | 181.8 | 92.6 | 64 | 235.2 | 119.9 |
| 25 | 22.3 | 11.3 | 85 | 75.7 | 38.6 | 45 | 129.2 | 65.8 | 05 | 182.7 | 93.1 | 65 | 236.1 | 120.3 |
| 26 | 23.2 | 11.8 | 86 | 76.6 | 39.0 | 46 | 130.1 | 66.3 | 06 | 183.5 | 93.5 | 66 | 237.0 | 120.8 |
| 27 | 24.1 | 12.3 | 87 | 77.5 | 39.5 | 47 | 131.0 | 66.7 | 07 | 184.4 | 94.0 | 67 | 237.9 | 121.2 |
| 28 | 24.9 | 12.7 | 88 | 78.4 | 40.0 | 48 | 131.9 | 67.2 | 08 | 185.3 | 94.4 | 68 | 238.8 | 121.7 |
| 29 | 25.8 | 13.2 | 89 | 79.3 | 40.4 | 49 | 132.8 | 67.6 | 09 | 186.2 | 94.9 | 69 | 239.7 | 122.1 |
| 30 | 26.7 | 13.6 | 90 | 80.2 | 40.9 | 50 | 133.7 | 68.1 | 10 | 187.1 | 95.3 | 70 | 240.6 | 122.6 |
| 31 | 27.6 | 14.1 | 91 | 81.1 | 41.3 | 151 | 134.5 | 68.6 | 211 | 188.0 | 95.8 | 271 | 241.5 | 123.0 |
| 32 | 28.5 | 14.5 | 92 | 82.0 | 41.8 | 52 | 135.4 | 69.0 | 12 | 188.9 | 96.2 | 72 | 242.4 | 123.5 |
| 33 | 29.4 | 15.0 | 93 | 82.9 | 42.2 | 53 | 136.3 | 69.5 | 13 | 189.8 | 96.7 | 73 | 243.2 | 123.9 |
| 34 | 30.3 | 15.4 | 94 | 83.8 | 42.7 | 54 | 137.2 | 69.9 | 14 | 190.7 | 97.2 | 74 | 244.1 | 124.4 |
| 35 | 31.2 | 15.9 | 95 | 84.6 | 43.1 | 55 | 138.1 | 70.4 | 15 | 191.6 | 97.6 | 75 | 245.0 | 124.8 |
| 36 | 32.1 | 16.3 | 96 | 85.5 | 43.6 | 56 | 139.0 | 70.8 | 16 | 192.5 | 98.1 | 76 | 245.9 | 125.3 |
| 37 | 33.0 | 16.8 | 97 | 86.4 | 44.0 | 57 | 139.9 | 71.3 | 17 | 193.3 | 98.5 | 77 | 246.8 | 125.8 |
| 38 | 33.9 | 17.3 | 98 | 87.3 | 44.5 | 58 | 140.8 | 71.7 | 18 | 194.2 | 99.0 | 78 | 247.7 | 126.2 |
| 39 | 34.7 | 17.7 | 99 | 88.2 | 44.9 | 59 | 141.7 | 72.2 | 19 | 195.1 | 99.4 | 79 | 248.6 | 126.7 |
| 40 | 35.6 | 18.2 | 100 | 89.1 | 45.4 | 60 | 142.6 | 72.6 | 20 | 196.0 | 99.9 | 80 | 249.5 | 127.1 |
| 41 | 36.5 | 18.6 | 101 | 90.0 | 45.9 | 161 | 143.5 | 73.1 | 221 | 196.9 | 100.3 | 281 | 250.4 | 127.6 |
| 42 | 37.4 | 19.1 | 02 | 90.9 | 46.3 | 62 | 144.3 | 73.5 | 22 | 197.8 | 100.8 | 82 | 251.3 | 128.0 |
| 43 | 38.3 | 19.5 | 03 | 91.8 | 46.8 | 63 | 145.2 | 74.0 | 23 | 198.7 | 101.2 | 83 | 252.2 | 128.5 |
| 44 | 39.2 | 20.0 | 04 | 92.7 | 47.2 | 64 | 146.1 | 74.5 | 24 | 199.6 | 101.7 | 84 | 253.0 | 128.9 |
| 45 | 40.1 | 20.4 | 05 | 93.6 | 47.7 | 65 | 147.0 | 74.9 | 25 | 200.5 | 102.1 | 85 | 253.9 | 129.4 |
| 46 | 41.0 | 20.9 | 06 | 94.4 | 48.1 | 66 | 147.9 | 75.4 | 26 | 201.4 | 102.6 | 86 | 254.8 | 129.8 |
| 47 | 41.9 | 21.3 | 07 | 95.3 | 48.6 | 67 | 148.8 | 75.8 | 27 | 202.3 | 103.1 | 87 | 255.7 | 130.3 |
| 48 | 42.8 | 21.8 | 08 | 96.2 | 49.0 | 68 | 149.7 | 76.3 | 28 | 203.1 | 103.5 | 88 | 256.6 | 130.7 |
| 49 | 43.7 | 22.2 | 09 | 97.1 | 49.5 | 69 | 150.6 | 76.7 | 29 | 204.0 | 104.0 | 89 | 257.5 | 131.2 |
| 50 | 44.6 | 22.7 | 10 | 98.0 | 49.9 | 70 | 151.5 | 77.2 | 30 | 204.9 | 104.4 | 90 | 258.4 | 131.7 |
| 51 | 45.4 | 23.2 | 111 | 98.9 | 50.4 | 171 | 152.4 | 77.6 | 231 | 205.8 | 104.9 | 291 | 259.3 | 132.1 |
| 52 | 46.3 | 23.6 | 12 | 99.8 | 50.8 | 72 | 153.3 | 78.1 | 32 | 206.7 | 105.3 | 92 | 260.2 | 132.6 |
| 53 | 47.2 | 24.1 | 13 | 100.7 | 51.3 | 73 | 154.1 | 78.5 | 33 | 207.6 | 105.8 | 93 | 261.1 | 133.0 |
| 54 | 48.1 | 24.5 | 14 | 101.6 | 51.8 | 74 | 155.0 | 79.0 | 34 | 208.5 | 106.2 | 94 | 262.0 | 133.5 |
| 55 | 49.0 | 25.0 | 15 | 102.5 | 52.2 | 75 | 155.9 | 79.4 | 35 | 209.4 | 106.7 | 95 | 262.8 | 133.9 |
| 56 | 49.9 | 25.4 | 16 | 103.4 | 52.7 | 76 | 156.8 | 79.9 | 36 | 210.3 | 107.1 | 96 | 263.7 | 134.4 |
| 57 | 50.8 | 25.9 | 17 | 104.2 | 53.1 | 77 | 157.7 | 80.4 | 37 | 211.2 | 107.6 | 97 | 264.6 | 134.8 |
| 58 | 51.7 | 26.3 | 18 | 105.1 | 53.6 | 78 | 158.6 | 80.8 | 38 | 212.1 | 108.0 | 98 | 265.5 | 135.3 |
| 59 | 52.6 | 26.8 | 19 | 106.0 | 54.0 | 79 | 159.5 | 81.3 | 39 | 213.0 | 108.5 | 99 | 266.4 | 135.7 |
| 60 | 53.5 | 27.2 | 20 | 106.9 | 54.5 | 80 | 160.4 | 81.7 | 40 | 213.8 | 109.0 | 300 | 267.3 | 136.2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 63° (117°, 243°, 297°).

TABLE 2. [Page 421

Difference of Latitude and Departure for 27° (153°, 207°, 333°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 268.2 | 136.7 | 361 | 321.7 | 163.9 | 421 | 375.1 | 191.1 | 481 | 428.6 | 218.3 | 541 | 482.0 | 245.6 |
| 02 | 269.1 | 137.1 | 62 | 322.5 | 164.4 | 22 | 376.0 | 191.6 | 82 | 429.4 | 218.8 | 42 | 482.9 | 246.1 |
| 03 | 270.0 | 137.6 | 63 | 323.4 | 164.8 | 23 | 376.9 | 192.0 | 83 | 430.3 | 219.2 | 43 | 483.8 | 246.5 |
| 04 | 270.9 | 138.0 | 64 | 324.3 | 165.3 | 24 | 377.8 | 192.5 | 84 | 431.2 | 219.7 | 44 | 484.7 | 247.0 |
| 05 | 271.8 | 138.5 | 65 | 325.2 | 165.7 | 25 | 378.7 | 193.0 | 85 | 432.1 | 220.1 | 45 | 485.6 | 247.4 |
| 06 | 272.7 | 138.9 | 66 | 326.1 | 166.2 | 26 | 379.6 | 193.4 | 86 | 433.0 | 220.6 | 46 | 486.4 | 247.9 |
| 07 | 273.5 | 139.4 | 67 | 327.0 | 166.6 | 27 | 380.5 | 193.9 | 87 | 433.9 | 221.1 | 47 | 487.3 | 248.4 |
| 08 | 274.4 | 139.8 | 68 | 327.9 | 167.1 | 28 | 381.4 | 194.3 | 88 | 434.8 | 221.5 | 48 | 488.2 | 248.8 |
| 09 | 275.3 | 140.3 | 69 | 328.8 | 167.5 | 29 | 382.2 | 194.8 | 89 | 435.7 | 222.0 | 49 | 489.1 | 249.2 |
| 10 | 276.2 | 140.7 | 70 | 329.7 | 168.0 | 30 | 383.1 | 195.2 | 90 | 436.6 | 222.4 | 50 | 490.0 | 249.7 |
| 311 | 277.1 | 141.2 | 371 | 330.6 | 168.4 | 431 | 384.0 | 195.7 | 491 | 437.5 | 222.9 | 551 | 490.9 | 250..1 |
| 12 | 278.0 | 141.7 | 72 | 331.5 | 168.9 | 32 | 384.9 | 196.1 | 92 | 438.3 | 223.3 | 52 | 491.8 | 250.6 |
| 13 | 278.9 | 142.1 | 73 | 332.3 | 169.3 | 33 | 385.8 | 196.6 | 93 | 439.2 | 223.8 | 53 | 492.7 | 251.0 |
| 14 | 279.8 | 142.6 | 74 | 333.2 | 169.8 | 34 | 386.7 | 197.0 | 94 | 440.1 | 224.2 | 54 | 493.6 | 251.5 |
| 15 | 280.7 | 143.0 | 75 | 334.1 | 170.3 | 35 | 387.6 | 197.5 | 95 | 441.0 | 224.7 | 55 | 494.5 | 252.0 |
| 16 | 281.6 | 143.5 | 76 | 335.0 | 170.7 | 36 | 388.5 | 197.9 | 96 | 441.9 | 225.2 | 56 | 495.4 | 252.4 |
| 17 | 282.5 | 143.9 | 77 | 335.9 | 171.2 | 37 | 389.4 | 198.4 | 97 | 442.8 | 225.6 | 57 | 496.3 | 252.9 |
| 18 | 283.3 | 144.4 | 78 | 336.8 | 171.6 | 38 | 390.3 | 198.9 | 98 | 443.7 | 226.1 | 58 | 497.2 | 253.3 |
| 19 | 284.2 | 144.8 | 79 | 337.7 | 172.1 | 39 | 391.2 | 199.3 | 99 | 444.6 | 226.5 | 59 | 498.1 | 253.8 |
| 20 | 285.1 | 145.3 | 80 | 338.6 | 172.5 | 40 | 392.0 | 199.8 | 500 | 445.5 | 227.0 | 60 | 499.0 | 254.2 |
| 321 | 286.0 | 145.7 | 381 | 339.5 | 173.0 | 441 | 392.9 | 200.2 | 501 | 446.4 | 227.5 | 561 | 499.8 | 254.7 |
| 22 | 286.9 | 146.2 | 82 | 340.4 | 173.4 | 42 | 393.8 | 200.7 | 02 | 447.3 | 227.9 | 62 | 500.7 | 255.1 |
| 23 | 287.8 | 146.6 | 83 | 341.3 | 173.9 | 43 | 394.7 | 201.1 | 03 | 448.2 | 228.4 | 63 | 501.6 | 255.6 |
| 24 | 288.7 | 147.1 | 84 | 342.1 | 174.3 | 44 | 395.6 | 201.6 | 04 | 449.0 | 228.8 | 64 | 502.5 | 256.0 |
| 25 | 289.6 | 147.6 | 85 | 343.0 | 174.8 | 45 | 396.5 | 202.0 | 05 | 449.9 | 229.3 | 65 | 503.4 | 256.5 |
| 26 | 290.5 | 148.0 | 86 | 343.9 | 175.2 | 46 | 397.4 | 202.5 | 06 | 450.8 | 229.8 | 66 | 504.3 | 257.0 |
| 27 | 291.4 | 148.5 | 87 | 344.8 | 175.7 | 47 | 398.3 | 202.9 | 07 | 451.7 | 230.2 | 67 | 505.2 | 257.4 |
| 28 | 292.3 | 148.9 | 88 | 345.7 | 176.2 | 48 | 399.2 | 203.4 | 08 | 452.6 | 230.6 | 68 | 506.1 | 257.9 |
| 29 | 293.2 | 149.4 | 89 | 346.6 | 176.6 | 49 | 400.1 | 203.8 | 09 | 453.5 | 231.0 | 69 | 507.0 | 258.3 |
| 30 | 294.0 | 149.8 | 90 | 347.5 | 177.1 | 50 | 401.0 | 204.3 | 10 | 454.4 | 231.5 | 70 | 507.9 | 258.8 |
| 331 | 294.9 | 150.3 | 391 | 348.4 | 177.5 | 451 | 401.8 | 204.7 | 511 | 455.3 | 231.9 | 571 | 508.7 | 259.2 |
| 32 | 295.8 | 150.7 | 92 | 349.3 | 178.0 | 52 | 402.7 | 205.2 | 12 | 456.2 | 232.4 | 72 | 509.6 | 259.7 |
| 33 | 296.7 | 151.2 | 93 | 350.2 | 178.4 | 53 | 403.6 | 205.7 | 13 | 457.1 | 232.9 | 73 | 510.5 | 260.1 |
| 34 | 297.6 | 151.6 | 94 | 351.1 | 178.9 | 54 | 404.5 | 206.1 | 14 | 458.0 | 233.3 | 74 | 511.4 | 260.6 |
| 35 | 298.5 | 152.1 | 95 | 352.0 | 179.3 | 55 | 405.4 | 206.6 | 15 | 458.8 | 233.8 | 75 | 512.3 | 261.1 |
| 36 | 299.4 | 152.5 | 96 | 352.8 | 179.8 | 56 | 406.3 | 207.0 | 16 | 459.7 | 234.2 | 76 | 513.2 | 261.5 |
| 37 | 300.3 | 153.0 | 97 | 353.7 | 180.2 | 57 | 407.2 | 207.5 | 17 | 460.6 | 234.7 | 77 | 514.1 | 262.0 |
| 38 | 301.2 | 153.5 | 98 | 354.6 | 180.7 | 58 | 408.1 | 207.9 | 18 | 461.5 | 235.2 | 78 | 515.0 | 262.4 |
| 39 | 302.1 | 153.9 | 99 | 355.5 | 181.2 | 59 | 409.0 | 208.4 | 19 | 462.4 | 235.7 | 79 | 515.9 | 262.9 |
| 40 | 302.9 | 154.4 | 400 | 356.4 | 181.6 | 60 | 409.9 | 208.8 | 20 | 463.3 | 236.1 | 80 | 516.8 | 263.4 |
| 341 | 303.8 | 154.8 | 401 | 357.3 | 182.1 | 461 | 410.8 | 209.3 | 521 | 464.2 | 236.6 | 581 | 517.7 | 263.8 |
| 42 | 304.7 | 155.3 | 02 | 358.2 | 182.5 | 62 | 411.6 | 209.8 | 22 | 465.1 | 237.0 | 82 | 518.5 | 264.3 |
| 43 | 305.6 | 155.7 | 03 | 359.1 | 183.0 | 63 | 412.5 | 210.2 | 23 | 466.0 | 237.5 | 83 | 519.4 | 264.7 |
| 44 | 306.5 | 156.2 | 04 | 360.0 | 183.4 | 64 | 413.4 | 210.7 | 24 | 466.9 | 237.9 | 84 | 520.3 | 265.2 |
| 45 | 307.4 | 156.6 | 05 | 360.9 | 183.9 | 65 | 414.3 | 211.1 | 25 | 467.8 | 238.4 | 85 | 521.2 | 265.6 |
| 46 | 308.3 | 157.1 | 06 | 361.8 | 184.3 | 66 | 415.2 | 211.6 | 26 | 468.7 | 238.8 | 86 | 522.1 | 266.0 |
| 47 | 309.2 | 157.5 | 07 | 362.6 | 184.8 | 67 | 416.1 | 212.0 | 27 | 469.5 | 239.3 | 87 | 523.0 | 266.5 |
| 48 | 310.1 | 158.0 | 08 | 363.5 | 185.2 | 68 | 417.0 | 212.5 | 28 | 470.4 | 239.7 | 88 | 523.9 | 267.0 |
| 49 | 311.0 | 158.5 | 09 | 364.4 | 185.7 | 69 | 417.9 | 212.9 | 29 | 471.3 | 240.2 | 89 | 524.8 | 267.4 |
| 50 | 311.9 | 158.9 | 10 | 365.3 | 186.1 | 70 | 418.8 | 213.4 | 30 | 472.2 | 240.6 | 90 | 525.7 | 267.9 |
| 351 | 312.7 | 159.4 | 411 | 366.2 | 186.6 | 471 | 419.7 | 213.8 | 531 | 473.1 | 241.1 | 591 | 526.6 | 268.3 |
| 52 | 313.6 | 159.8 | 12 | 367.1 | 187.1 | 72 | 420.6 | 214.3 | 32 | 474.0 | 241.5 | 92 | 527.5 | 268.8 |
| 53 | 314.5 | 160.3 | 13 | 368.0 | 187.5 | 73 | 421.4 | 214.7 | 33 | 474.9 | 242.0 | 93 | 528.4 | 269.2 |
| 54 | 315.4 | 160.7 | 14 | 368.9 | 188.0 | 74 | 422.3 | 215.2 | 34 | 475.8 | 242.4 | 94 | 529.3 | 269.7 |
| 55 | 316.3 | 161.2 | 15 | 369.8 | 188.4 | 75 | 423.2 | 215.7 | 35 | 476.7 | 242.9 | 95 | 530.1 | 270.1 |
| 56 | 317.2 | 161.6 | 16 | 370.7 | 188.9 | 76 | 424.1 | 216.1 | 36 | 477.6 | 243.4 | 96 | 531.0 | 270.6 |
| 57 | 318.1 | 162.1 | 17 | 371.6 | 189.3 | 77 | 425.0 | 216.6 | 37 | 478.4 | 243.8 | 97 | 531.9 | 271.1 |
| 58 | 319.0 | 162.5 | 18 | 372.4 | 189.8 | 78 | 425.9 | 217.0 | 38 | 479.3 | 244.3 | 98 | 532.8 | 271.5 |
| 59 | 319.9 | 163.0 | 19 | 373.3 | 190.2 | 79 | 426.8 | 217.5 | 39 | 480.2 | 244.7 | 99 | 533.7 | 272.0 |
| 60 | 320.8 | 163.4 | 20 | 374.2 | 190.7 | 80 | 427.7 | 217.9 | 40 | 481.1 | 245.2 | 600 | 534.6 | 272.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

63° (117°, 243°, 297°).

# TABLE 2.

Difference of Latitude and Departure for 28° (152°, 208°, 332°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.5 | 61 | 53.9 | 28.6 | 121 | 106.8 | 56.8 | 181 | 159.8 | 85.0 | 241 | 212.8 | 113.1 |
| 2 | 1.8 | 0.9 | 62 | 54.7 | 29.1 | 22 | 107.7 | 57.3 | 82 | 160.7 | 85.4 | 42 | 213.7 | 113.6 |
| 3 | 2.6 | 1.4 | 63 | 55.6 | 29.6 | 23 | 108.6 | 57.7 | 83 | 161.6 | 85.9 | 43 | 214.6 | 114.1 |
| 4 | 3.5 | 1.9 | 64 | 56.5 | 30.0 | 24 | 109.5 | 58.2 | 84 | 162.5 | 86.4 | 44 | 215.4 | 114.6 |
| 5 | 4.4 | 2.3 | 65 | 57.4 | 30.5 | 25 | 110.4 | 58.7 | 85 | 163.3 | 86.9 | 45 | 216.3 | 115.0 |
| 6 | 5.3 | 2.8 | 66 | 58.3 | 31.0 | 26 | 111.3 | 59.2 | 86 | 164.2 | 87.3 | 46 | 217.2 | 115.5 |
| 7 | 6.2 | 3.3 | 67 | 59.2 | 31.5 | 27 | 112.1 | 59.6 | 87 | 165.1 | 87.8 | 47 | 218.1 | 116.0 |
| 8 | 7.1 | 3.8 | 68 | 60.0 | 31.9 | 28 | 113.0 | 60.1 | 88 | 166.0 | 88.3 | 48 | 219.0 | 116.4 |
| 9 | 7.9 | 4.2 | 69 | 60.9 | 32.4 | 29 | 113.9 | 60.6 | 89 | 166.9 | 88.7 | 49 | 219.9 | 116.9 |
| 10 | 8.8 | 4.7 | 70 | 61.8 | 32.9 | 30 | 114.8 | 61.0 | 90 | 167.8 | 89.2 | 50 | 220.7 | 117.4 |
| 11 | 9.7 | 5.2 | 71 | 62.7 | 33.3 | 131 | 115.7 | 61.5 | 191 | 168.6 | 89.7 | 251 | 221.6 | 117.8 |
| 12 | 10.6 | 5.6 | 72 | 63.6 | 33.8 | 32 | 116.5 | 62.0 | 92 | 169.5 | 90.1 | 52 | 222.5 | 118.3 |
| 13 | 11.5 | 6.1 | 73 | 64.5 | 34.3 | 33 | 117.4 | 62.4 | 93 | 170.4 | 90.6 | 53 | 223.4 | 118.8 |
| 14 | 12.4 | 6.6 | 74 | 65.3 | 34.7 | 34 | 118.3 | 62.9 | 94 | 171.3 | 91.1 | 54 | 224.3 | 119.2 |
| 15 | 13.2 | 7.0 | 75 | 66.2 | 35.2 | 35 | 119.2 | 63.4 | 95 | 172.2 | 91.5 | 55 | 225.2 | 119.7 |
| 16 | 14.1 | 7.5 | 76 | 67.1 | 35.7 | 36 | 120.1 | 63.8 | 96 | 173.1 | 92.0 | 56 | 226.0 | 120.2 |
| 17 | 15.0 | 8.0 | 77 | 68.0 | 36.1 | 37 | 121.0 | 64.3 | 97 | 173.9 | 92.5 | 57 | 226.9 | 120.7 |
| 18 | 15.9 | 8.5 | 78 | 68.9 | 36.6 | 38 | 121.8 | 64.8 | 98 | 174.8 | 93.0 | 58 | 227.8 | 121.1 |
| 19 | 16.8 | 8.9 | 79 | 69.8 | 37.1 | 39 | 122.7 | 65.3 | 99 | 175.7 | 93.4 | 59 | 228.7 | 121.6 |
| 20 | 17.7 | 9.4 | 80 | 70.6 | 37.6 | 40 | 123.6 | 65.7 | 200 | 176.6 | 93.9 | 60 | 229.6 | 122.1 |
| 21 | 18.5 | 9.9 | 81 | 71.5 | 38.0 | 141 | 124.5 | 66.2 | 201 | 177.5 | 94.4 | 261 | 230.4 | 122.5 |
| 22 | 19.4 | 10.3 | 82 | 72.4 | 38.5 | 42 | 125.4 | 66.7 | 02 | 178.4 | 94.8 | 62 | 231.3 | 123.0 |
| 23 | 20.3 | 10.8 | 83 | 73.3 | 39.0 | 43 | 126.3 | 67.1 | 03 | 179.2 | 95.3 | 63 | 232.2 | 123.5 |
| 24 | 21.2 | 11.3 | 84 | 74.2 | 39.4 | 44 | 127.1 | 67.6 | 04 | 180.1 | 95.8 | 64 | 233.1 | 123.9 |
| 25 | 22.1 | 11.7 | 85 | 75.1 | 39.9 | 45 | 128.0 | 68.1 | 05 | 181.0 | 96.2 | 65 | 234.0 | 124.4 |
| 26 | 23.0 | 12.2 | 86 | 75.9 | 40.4 | 46 | 128.9 | 68.5 | 06 | 181.9 | 96.7 | 66 | 234.9 | 124.9 |
| 27 | 23.8 | 12.7 | 87 | 76.8 | 40.8 | 47 | 129.8 | 69.0 | 07 | 182.8 | 97.2 | 67 | 235.7 | 125.3 |
| 28 | 24.7 | 13.1 | 88 | 77.7 | 41.3 | 48 | 130.7 | 69.5 | 08 | 183.7 | 97.7 | 68 | 236.6 | 125.8 |
| 29 | 25.6 | 13.6 | 89 | 78.6 | 41.8 | 49 | 131.6 | 70.0 | 09 | 184.5 | 98.1 | 69 | 237.5 | 126.3 |
| 30 | 26.5 | 14.1 | 90 | 79.5 | 42.3 | 50 | 132.4 | 70.4 | 10 | 185.4 | 98.6 | 70 | 238.4 | 126.8 |
| 31 | 27.4 | 14.6 | 91 | 80.3 | 42.7 | 151 | 133.3 | 70.9 | 211 | 186.3 | 99.1 | 271 | 239.3 | 127.2 |
| 32 | 28.3 | 15.0 | 92 | 81.2 | 43.2 | 52 | 134.2 | 71.4 | 12 | 187.2 | 99.5 | 72 | 240.2 | 127.7 |
| 33 | 29.1 | 15.5 | 93 | 82.1 | 43.7 | 53 | 135.1 | 71.8 | 13 | 188.1 | 100.0 | 73 | 241.0 | 128.2 |
| 34 | 30.0 | 16.0 | 94 | 83.0 | 44.1 | 54 | 136.0 | 72.3 | 14 | 189.0 | 100.5 | 74 | 241.9 | 128.6 |
| 35 | 30.9 | 16.4 | 95 | 83.9 | 44.6 | 55 | 136.9 | 72.8 | 15 | 189.8 | 100.9 | 75 | 242.8 | 129.1 |
| 36 | 31.8 | 16.9 | 96 | 84.8 | 45.1 | 56 | 137.7 | 73.2 | 16 | 190.7 | 101.4 | 76 | 243.7 | 129.6 |
| 37 | 32.7 | 17.4 | 97 | 85.6 | 45.5 | 57 | 138.6 | 73.7 | 17 | 191.6 | 101.9 | 77 | 244.6 | 130.0 |
| 38 | 33.6 | 17.8 | 98 | 86.5 | 46.0 | 58 | 139.5 | 74.2 | 18 | 192.5 | 102.3 | 78 | 245.5 | 130.5 |
| 39 | 34.4 | 18.3 | 99 | 87.4 | 46.5 | 59 | 140.4 | 74.6 | 19 | 193.4 | 102.8 | 79 | 246.3 | 131.0 |
| 40 | 35.3 | 18.8 | 100 | 88.3 | 46.9 | 60 | 141.3 | 75.1 | 20 | 194.2 | 103.3 | 80 | 247.2 | 131.5 |
| 41 | 36.2 | 19.2 | 101 | 89.2 | 47.4 | 161 | 142.2 | 75.6 | 221 | 195.1 | 103.8 | 281 | 248.1 | 131.9 |
| 42 | 37.1 | 19.7 | 02 | 90.1 | 47.9 | 62 | 143.0 | 76.1 | 22 | 196.0 | 104.2 | 82 | 249.0 | 132.4 |
| 43 | 38.0 | 20.2 | 03 | 90.9 | 48.4 | 63 | 143.9 | 76.5 | 23 | 196.9 | 104.7 | 83 | 249.9 | 132.9 |
| 44 | 38.8 | 20.7 | 04 | 91.8 | 48.8 | 64 | 144.8 | 77.0 | 24 | 197.8 | 105.2 | 84 | 250.8 | 133.3 |
| 45 | 39.7 | 21.1 | 05 | 92.7 | 49.3 | 65 | 145.7 | 77.5 | 25 | 198.7 | 105.6 | 85 | 251.6 | 133.8 |
| 46 | 40.6 | 21.6 | 06 | 93.6 | 49.8 | 66 | 146.6 | 77.9 | 26 | 199.5 | 106.1 | 86 | 252.5 | 134.3 |
| 47 | 41.5 | 22.1 | 07 | 94.5 | 50.2 | 67 | 147.5 | 78.4 | 27 | 200.4 | 106.6 | 87 | 253.4 | 134.7 |
| 48 | 42.4 | 22.5 | 08 | 95.4 | 50.7 | 68 | 148.3 | 78.9 | 28 | 201.3 | 107.0 | 88 | 254.3 | 135.2 |
| 49 | 43.3 | 23.0 | 09 | 96.2 | 51.2 | 69 | 149.2 | 79.3 | 29 | 202.2 | 107.5 | 89 | 255.2 | 135.7 |
| 50 | 44.1 | 23.5 | 10 | 97.1 | 51.6 | 70 | 150.1 | 79.8 | 30 | 203.1 | 108.0 | 90 | 256.1 | 136.1 |
| 51 | 45.0 | 23.9 | 111 | 98.0 | 52.1 | 171 | 151.0 | 80.3 | 231 | 204.0 | 108.4 | 291 | 256.9 | 136.6 |
| 52 | 45.9 | 24.4 | 12 | 98.9 | 52.6 | 72 | 151.9 | 80.7 | 32 | 204.8 | 108.9 | 92 | 257.8 | 137.1 |
| 53 | 46.8 | 24.9 | 13 | 99.8 | 53.1 | 73 | 152.7 | 81.2 | 33 | 205.7 | 109.4 | 93 | 258.7 | 137.6 |
| 54 | 47.7 | 25.4 | 14 | 100.7 | 53.5 | 74 | 153.6 | 81.7 | 34 | 206.6 | 109.9 | 94 | 259.6 | 138.0 |
| 55 | 48.6 | 25.8 | 15 | 101.5 | 54.0 | 75 | 154.5 | 82.2 | 35 | 207.5 | 110.3 | 95 | 260.5 | 138.5 |
| 56 | 49.4 | 26.3 | 16 | 102.4 | 54.5 | 76 | 155.4 | 82.6 | 36 | 208.4 | 110.8 | 96 | 261.4 | 139.0 |
| 57 | 50.3 | 26.8 | 17 | 103.3 | 54.9 | 77 | 156.3 | 83.1 | 37 | 209.3 | 111.3 | 97 | 262.2 | 139.4 |
| 58 | 51.2 | 27.2 | 18 | 104.2 | 55.4 | 78 | 157.2 | 83.6 | 38 | 210.1 | 111.7 | 98 | 263.1 | 139.9 |
| 59 | 52.1 | 27.7 | 19 | 105.1 | 55.9 | 79 | 158.0 | 84.0 | 39 | 211.0 | 112.2 | 99 | 264.0 | 140.4 |
| 60 | 53.0 | 28.2 | 20 | 106.0 | 56.3 | 80 | 158.9 | 84.5 | 40 | 211.9 | 112.7 | 300 | 264.9 | 140.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

62° (118°, 242°, 298°).

TABLE 2. [Page 423

Difference of Latitude and Departure for 28° (152°, 208°, 332°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 265.7 | 141.3 | 361 | 318.7 | 169.5 | 421 | 371.7 | 197.7 | 481 | 424.7 | 225.8 | 541 | 477.7 | 254.0 |
| 02 | 266.6 | 141.8 | 62 | 319.6 | 170.0 | 22 | 372.6 | 198.1 | 82 | 425.6 | 226.3 | 42 | 478.6 | 254.5 |
| 03 | 267.5 | 142.3 | .63 | 320.5 | 170.4 | 23 | 373.5 | 198.6 | 83 | 426.5 | 226.8 | 43 | 479.4 | 255.0 |
| 04 | 268.4 | 142.7 | 64 | 321.4 | 170.9 | 24 | 374.3 | 199.1 | 84 | 427.4 | 227.3 | 44 | 480.3 | 255.5 |
| 05 | 269.3 | 143.2 | 65 | 322.2 | 171.4 | 25 | 375.2 | 199.5 | 85 | 428.3 | 227.7 | 45 | 481.1 | 255.9 |
| 06 | 270.2 | 143.7 | 66 | 323.1 | 171.8 | 26 | 376.1 | 200.0 | 86 | 429.2 | 228.2 | 46 | 482.0 | 256.4 |
| 07 | 271.0 | 144.1 | 67 | 324.0 | 172.3 | 27 | 377.0 | 200.5 | 87 | 430.1 | 228.6 | 47 | 482.9 | 256.9 |
| 08 | 271.9 | 144.6 | 68 | 324.9 | 172.8 | 28 | 377.9 | 200.9 | 88 | 430.9 | 229.1 | 48 | 483.8 | 257.3 |
| 09 | 272.8 | 145.1 | 69 | 325.8 | 173.2 | 29 | 378.8 | 201.4 | 89 | 431.8 | 229.6 | 49 | 484.7 | 257.8 |
| 10 | 273.7 | 145.5 | 70 | 326.7 | 173.7 | 30 | 379.6 | 201.9 | 90 | 432.6 | 230.0 | 50 | 485.6 | 258.2 |
| 311 | 274.6 | 146.0 | 371 | 327.5 | 174.2 | 431 | 380.5 | 202.3 | 491 | 433.5 | 230.5 | 551 | 486.5 | 258.7 |
| 12 | 275.5 | 146.5 | 72 | 328.4 | 174.6 | 32 | 381.4 | 202.8 | 92 | 434.4 | 231.0 | 52 | 487.4 | 259.1 |
| 13 | 276.3 | 146.9 | 73 | 329.3 | 175.1 | 33 | 382.3 | 203.3 | 93 | 435.3 | 231.4 | 53 | 488.3 | 259.6 |
| 14 | 277.2 | 147.4 | 74 | 330.2 | 175.6 | 34 | 383.2 | 203.8 | 94 | 436.2 | 231.9 | 54 | 489.2 | 260.1 |
| 15 | 278.1 | 147.9 | 75 | 331.1 | 176.1 | 35 | 384.1 | 204.2 | 95 | 437.1 | 232.4 | 55 | 490.1 | 260.6 |
| 16 | 279.0 | 148.4 | 76 | 332.0 | 176.5 | 36 | 384.9 | 204.7 | 96 | 437.9 | 232.9 | 56 | 490.9 | 261.0 |
| 17 | 279.9 | 148.8 | 77 | 332.8 | 177.0 | 37 | 385.8 | 205.2 | 97 | 438.8 | 233.4 | 57 | 491.8 | 261.5 |
| 18 | 280.7 | 149.3 | 78 | 333.7 | 177.5 | 38 | 386.7 | 205.6 | 98 | 439.7 | 233.8 | 58 | 492.7 | 262.0 |
| 19 | 281.6 | 149.8 | 79 | 334.6 | 177.9 | 39 | 387.6 | 206.1 | 99 | 440.6 | 234.3 | 59 | 493.5 | 262.5 |
| 20 | 282.5 | 150.2 | 80 | 335.5 | 178.4 | 40 | 388.5 | 206.6 | 500 | 441.5 | 234.7 | 60 | 494.4 | 262.9 |
| 321 | 283.4 | 150.7 | 381 | 336.4 | 178.9 | 441 | 389.4 | 207.0 | 501 | 442.3 | 235.2 | 561 | 495.3 | 263.4 |
| 22 | 284.3 | 151.2 | 82 | 337.3 | 179.3 | 42 | 390.2 | 207.5 | 02 | 443.2 | 235.6 | 62 | 496.2 | 263.8 |
| 23 | 285.2 | 151.6 | 83 | 338.1 | 179.8 | 43 | 391.1 | 208.0 | 03 | 444.1 | 236.1 | 63 | 497.1 | 264.3 |
| 24 | 286.0 | 152.1 | 84 | 339.0 | 180.3 | 44 | 392.0 | 208.4 | 04 | 445.0 | 236.6 | 64 | 498.0 | 264.7 |
| 25 | 286.9 | 152.6 | 85 | 339.9 | 180.8 | 45 | 392.9 | 208.9 | 05 | 445.9 | 237.1 | 65 | 498.9 | 265.2 |
| 26 | 287.8 | 153.1 | 86 | 340.8 | 181.2 | 46 | 393.8 | 209.4 | 06 | 446.8 | 237.5 | 66 | 499.8 | 265.7 |
| 27 | 288.7 | 153.5 | 87 | 341.7 | 181.7 | 47 | 394.6 | 209.9 | 07 | 447.6 | 238.0 | 67 | 500.7 | 266.2 |
| 28 | 289.6 | 154.0 | 88 | 342.6 | 182.2 | 48 | 395.5 | 210.3 | 08 | 448.5 | 238.5 | 68 | 501.6 | 266.6 |
| 29 | 290.5 | 154.5 | 89 | 343.4 | 182.6 | 49 | 396.4 | 210.8 | 09 | 449.4 | 239.0 | 69 | 502.4 | 267.1 |
| 30 | 291.3 | 154.9 | 90 | 344.3 | 183.1 | 50 | 397.3 | 211.3 | 10 | 450.3 | 239.4 | 70 | 503.3 | 267.6 |
| 331 | 292.2 | 155.4 | 391 | 345.2 | 183.6 | 451 | 398.2 | 211.7 | 511 | 451.2 | 239.9 | 571 | 504.2 | 268.0 |
| 32 | 293.1 | 155.9 | 92 | 346.1 | 184.0 | 52 | 399.1 | 212.2 | 12 | 452.1 | 240.4 | 72 | 505.1 | 268.5 |
| 33 | 294.0 | 156.3 | 93 | 347.0 | 184.5 | 53 | 399.9 | 212.7 | 13 | 452.9 | 240.8 | 73 | 505.9 | 269.0 |
| 34 | 294.9 | 156.8 | 94 | 347.9 | 185.0 | 54 | 400.8 | 213.1 | 14 | 453.8 | 241.3 | 74 | 506.8 | 269.4 |
| 35 | 295.8 | 157.3 | 95 | 348.7 | 185.4 | 55 | 401.7 | 213.6 | 15 | 454.7 | 241.8 | 75 | 507.7 | 269.9 |
| 36 | 296.6 | 157.7 | 96 | 349.6 | 185.9 | 56 | 402.6 | 214.1 | 16 | 455.6 | 242.2 | 76 | 508.6 | 270.4 |
| 37 | 297.5 | 158.2 | 97 | 350.5 | 186.4 | 57 | 403.5 | 214.6 | 17 | 456.4 | 242.7 | 77 | 509.4 | 270.9 |
| 38 | 298.4 | 158.7 | 98 | 351.4 | 186.9 | 58 | 404.4 | 215.0 | 18 | 457.3 | 243.2 | 78 | 510.3 | 271.3 |
| 39 | 299.3 | 159.2 | 99 | 352.3 | 187.3 | 59 | 405.2 | 215.5 | 19 | 458.2 | 243.7 | 79 | 511.2 | 271.8 |
| 40 | 300.2 | 159.6 | 400 | 353.1 | 187.8 | 60 | 406.1 | 216.0 | 20 | 459.1 | 244.1 | 80 | 512.1 | 272.3 |
| 341 | 301.0 | 160.1 | 401 | 354.0 | 188.3 | 461 | 407.0 | 216.4 | 521 | 460.0 | 244.6 | 581 | 513.0 | 272.7 |
| 42 | 301.9 | 160.6 | 02 | 354.9 | 188.7 | 62 | 407.9 | 216.9 | 22 | 460.9 | 245.0 | 82 | 513.9 | 273.2 |
| 43 | 302.8 | 161.0 | 03 | 355.8 | 189.2 | 63 | 408.8 | 217.4 | 23 | 461.8 | 245.5 | 83 | 514.8 | 273.7 |
| 44 | 303.7 | 161.5 | 04 | 356.7 | 189.7 | 64 | 409.7 | 217.8 | 24 | 462.7 | 246.0 | 84 | 515.7 | 274.2 |
| 45 | 304.6 | 162.0 | 05 | 357.6 | 190.1 | 65 | 410.5 | 218.3 | 25 | 463.5 | 246.5 | 85 | 516.5 | 274.7 |
| 46 | 305.5 | 162.4 | 06 | 358.4 | 190.6 | 66 | 411.4 | 218.8 | 26 | 464.4 | 246.9 | 86 | 517.4 | 275.1 |
| 47 | 306.4 | 162.9 | 07 | 359.3 | 191.1 | 67 | 412.3 | 219.2 | 27 | 465.3 | 247.4 | 87 | 518.3 | 275.5 |
| 48 | 307.2 | 163.4 | 08 | 360.2 | 191.5 | 68 | 413.2 | 219.7 | 28 | 466.2 | 247.9 | 88 | 519.2 | 276.0 |
| 49 | 308.1 | 163.8 | 09 | 361.1 | 192.0 | 69 | 414.1 | 220.2 | 29 | 467.1 | 248.3 | 89 | 520.1 | 276.5 |
| 50 | 309.0 | 164.3 | 10 | 362.0 | 192.5 | 70 | 415.0 | 220.7 | 30 | 468.0 | 248.8 | 90 | 521.0 | 277.0 |
| 351 | 309.9 | 164.8 | 411 | 362.9 | 193.0 | 471 | 415.8 | 221.1 | 531 | 468.9 | 249.3 | 591 | 521.8 | 277.4 |
| 52 | 310.8 | 165.3 | 12 | 363.7 | 193.4 | 72 | 416.7 | 221.6 | 32 | 469.8 | 249.8 | 92 | 522.6 | 277.9 |
| 53 | 311.7 | 165.7 | 13 | 364.6 | 193.9 | 73 | 417.6 | 222.1 | 33 | 470.7 | 250.2 | 93 | 523.5 | 278.4 |
| 54 | 312.5 | 166.2 | 14 | 365.5 | 194.4 | 74 | 418.5 | 222.5 | 34 | 471.5 | 250.7 | 94 | 524.4 | 278.8 |
| 55 | 313.4 | 166.7 | 15 | 366.4 | 194.8 | 75 | 419.4 | 223.0 | 35 | 472.4 | 251.1 | 95 | 525.3 | 279.3 |
| 56 | 314.3 | 167.1 | 16 | 367.3 | 195.3 | 76 | 420.3 | 223.5 | 36 | 473.3 | 251.6 | 96 | 526.2 | 279.8 |
| 57 | 315.2 | 167.6 | 17 | 368.2 | 195.8 | 77 | 421.1 | 223.9 | 37 | 474.2 | 252.1 | 97 | 527.1 | 280.3 |
| 58 | 316.1 | 168.1 | 18 | 369.0 | 196.2 | 78 | 422.0 | 224.4 | 38 | 475.1 | 252.6 | 98 | 528.0 | 280.8 |
| 59 | 316.9 | 168.5 | 19 | 369.9 | 196.7 | 79 | 422.9 | 224.9 | 39 | 476.0 | 253.1 | 99 | 528.9 | 281.3 |
| 60 | 317.8 | 169.0 | 20 | 370.8 | 197.2 | 80 | 423.8 | 225.3 | 40 | 476.8 | 253.6 | 600 | 529.8 | 281.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

62° (118°, 242°, 298°).

# TABLE 2.

Difference of Latitude and Departure for 29° (151°, 209°, 331°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.5 | 61 | 53.4 | 29.6 | 121 | 105.8 | 58.7 | 181 | 158.3 | 87.8 | 241 | 210.8 | 116.8 |
| 2 | 1.7 | 1.0 | 62 | 54.2 | 30.1 | 22 | 106.7 | 59.1 | 82 | 159.2 | 88.2 | 42 | 211.7 | 117.3 |
| 3 | 2.6 | 1.5 | 63 | 55.1 | 30.5 | 23 | 107.6 | 59.6 | 83 | 160.1 | 88.7 | 43 | 212.5 | 117.8 |
| 4 | 3.5 | 1.9 | 64 | 56.0 | 31.0 | 24 | 108.5 | 60.1 | 84 | 160.9 | 89.2 | 44 | 213.4 | 118.3 |
| 5 | 4.4 | 2.4 | 65 | 56.9 | 31.5 | 25 | 109.3 | 60.6 | 85 | 161.8 | 89.7 | 45 | 214.3 | 118.8 |
| 6 | 5.2 | 2.9 | 66 | 57.7 | 32.0 | 26 | 110.2 | 61.1 | 86 | 162.7 | 90.2 | 46 | 215.2 | 119.3 |
| 7 | 6.1 | 3.4 | 67 | 58.6 | 32.5 | 27 | 111.1 | 61.6 | 87 | 163.6 | 90.7 | 47 | 216.0 | 119.7 |
| 8 | 7.0 | 3.9 | 68 | 59.5 | 33.0 | 28 | 112.0 | 62.1 | 88 | 164.4 | 91.1 | 48 | 216.9 | 120.2 |
| 9 | 7.9 | 4.4 | 69 | 60.3 | 33.5 | 29 | 112.8 | 62.5 | 89 | 165.3 | 91.6 | 49 | 217.8 | 120.7 |
| 10 | 8.7 | 4.8 | 70 | 61.2 | 33.9 | 30 | 113.7 | 63.0 | 90 | 166.2 | 92.1 | 50 | 218.7 | 121.2 |
| 11 | 9.6 | 5.3 | 71 | 62.1 | 34.4 | 131 | 114.6 | 63.5 | 191 | 167.1 | 92.6 | 251 | 219.5 | 121.7 |
| 12 | 10.5 | 5.8 | 72 | 63.0 | 34.9 | 32 | 115.4 | 64.0 | 92 | 167.9 | 93.1 | 52 | 220.4 | 122.2 |
| 13 | 11.4 | 6.3 | 73 | 63.8 | 35.4 | 33 | 116.3 | 64.5 | 93 | 168.8 | 93.6 | 53 | 221.3 | 122.7 |
| 14 | 12.2 | 6.8 | 74 | 64.7 | 35.9 | 34 | 117.2 | 65.0 | 94 | 169.7 | 94.1 | 54 | 222.2 | 123.1 |
| 15 | 13.1 | 7.3 | 75 | 65.6 | 36.4 | 35 | 118.1 | 65.4 | 95 | 170.6 | 94.5 | 55 | 223.0 | 123.6 |
| 16 | 14.0 | 7.8 | 76 | 66.5 | 36.8 | 36 | 118.9 | 65.9 | 96 | 171.4 | 95.0 | 56 | 223.9 | 124.1 |
| 17 | 14.9 | 8.2 | 77 | 67.3 | 37.3 | 37 | 119.8 | 66.4 | 97 | 172.3 | 95.5 | 57 | 224.8 | 124.6 |
| 18 | 15.7 | 8.7 | 78 | 68.2 | 37.8 | 38 | 120.7 | 66.9 | 98 | 173.2 | 96.0 | 58 | 225.7 | 125.1 |
| 19 | 16.6 | 9.2 | 79 | 69.1 | 38.3 | 39 | 121.6 | 67.4 | 99 | 174.0 | 96.5 | 59 | 226.5 | 125.6 |
| 20 | 17.5 | 9.7 | 80 | 70.0 | 38.8 | 40 | 122.4 | 67.9 | 200 | 174.9 | 97.0 | 60 | 227.4 | 126.1 |
| 21 | 18.4 | 10.2 | 81 | 70.8 | 39.3 | 141 | 123.3 | 68.4 | 201 | 175.8 | 97.4 | 261 | 228.3 | 126.5 |
| 22 | 19.2 | 10.7 | 82 | 71.7 | 39.8 | 42 | 124.2 | 68.8 | 02 | 176.7 | 97.9 | 62 | 229.2 | 127.0 |
| 23 | 20.1 | 11.2 | 83 | 72.6 | 40.2 | 43 | 125.1 | 69.3 | 03 | 177.5 | 98.4 | 63 | 230.0 | 127.5 |
| 24 | 21.0 | 11.6 | 84 | 73.5 | 40.7 | 44 | 125.9 | 69.8 | 04 | 178.4 | 98.9 | 64 | 230.9 | 128.0 |
| 25 | 21.9 | 12.1 | 85 | 74.3 | 41.2 | 45 | 126.8 | 70.3 | 05 | 179.3 | 99.4 | 65 | 231.8 | 128.5 |
| 26 | 22.7 | 12.6 | 86 | 75.2 | 41.7 | 46 | 127.7 | 70.8 | 06 | 180.2 | 99.9 | 66 | 232.6 | 129.0 |
| 27 | 23.6 | 13.1 | 87 | 76.1 | 42.2 | 47 | 128.6 | 71.3 | 07 | 181.0 | 100.4 | 67 | 233.5 | 129.4 |
| 28 | 24.5 | 13.6 | 88 | 77.0 | 42.7 | 48 | 129.4 | 71.8 | 08 | 181.9 | 100.8 | 68 | 234.4 | 129.9 |
| 29 | 25.4 | 14.1 | 89 | 77.8 | 43.1 | 49 | 130.3 | 72.2 | 09 | 182.8 | 101.3 | 69 | 235.3 | 130.4 |
| 30 | 26.2 | 14.5 | 90 | 78.7 | 43.6 | 50 | 131.2 | 72.7 | 10 | 183.7 | 101.8 | 70 | 236.1 | 130.9 |
| 31 | 27.1 | 15.0 | 91 | 79.6 | 44.1 | 151 | 132.1 | 73.2 | 211 | 184.5 | 102.3 | 271 | 237.0 | 131.4 |
| 32 | 28.0 | 15.5 | 92 | 80.5 | 44.6 | 52 | 132.9 | 73.7 | 12 | 185.4 | 102.8 | 72 | 237.9 | 131.9 |
| 33 | 28.9 | 16.0 | 93 | 81.3 | 45.1 | 53 | 133.8 | 74.2 | 13 | 186.3 | 103.3 | 73 | 238.8 | 132.4 |
| 34 | 29.7 | 16.5 | 94 | 82.2 | 45.6 | 54 | 134.7 | 74.7 | 14 | 187.2 | 103.7 | 74 | 239.6 | 132.8 |
| 35 | 30.6 | 17.0 | 95 | 83.1 | 46.1 | 55 | 135.6 | 75.1 | 15 | 188.0 | 104.2 | 75 | 240.5 | 133.3 |
| 36 | 31.5 | 17.5 | 96 | 84.0 | 46.5 | 56 | 136.4 | 75.6 | 16 | 188.9 | 104.7 | 76 | 241.4 | 133.8 |
| 37 | 32.4 | 17.9 | 97 | 84.8 | 47.0 | 57 | 137.3 | 76.1 | 17 | 189.8 | 105.2 | 77 | 242.3 | 134.3 |
| 38 | 33.2 | 18.4 | 98 | 85.7 | 47.5 | 58 | 138.2 | 76.6 | 18 | 190.7 | 105.7 | 78 | 243.1 | 134.8 |
| 39 | 34.1 | 18.9 | 99 | 86.6 | 48.0 | 59 | 139.1 | 77.1 | 19 | 191.5 | 106.2 | 79 | 244.0 | 135.3 |
| 40 | 35.0 | 19.4 | 100 | 87.5 | 48.5 | 60 | 139.9 | 77.6 | 20 | 192.4 | 106.7 | 80 | 244.9 | 135.7 |
| 41 | 35.9 | 19.9 | 101 | 88.3 | 49.0 | 161 | 140.8 | 78.1 | 221 | 193.3 | 107.1 | 281 | 245.8 | 136.2 |
| 42 | 36.7 | 20.4 | 02 | 89.2 | 49.5 | 62 | 141.7 | 78.5 | 22 | 194.2 | 107.6 | 82 | 246.6 | 136.7 |
| 43 | 37.6 | 20.8 | 03 | 90.1 | 49.9 | 63 | 142.6 | 79.0 | 23 | 195.0 | 108.1 | 83 | 247.5 | 137.2 |
| 44 | 38.5 | 21.3 | 04 | 91.0 | 50.4 | 64 | 143.4 | 79.5 | 24 | 195.9 | 108.6 | 84 | 248.4 | 137.7 |
| 45 | 39.4 | 21.8 | 05 | 91.8 | 50.9 | 65 | 144.3 | 80.0 | 25 | 196.8 | 109.1 | 85 | 249.3 | 138.2 |
| 46 | 40.2 | 22.3 | 06 | 92.7 | 51.4 | 66 | 145.2 | 80.5 | 26 | 197.7 | 109.6 | 86 | 250.1 | 138.7 |
| 47 | 41.1 | 22.8 | 07 | 93.6 | 51.9 | 67 | 146.1 | 81.0 | 27 | 198.5 | 110.1 | 87 | 251.0 | 139.1 |
| 48 | 42.0 | 23.3 | 08 | 94.5 | 52.4 | 68 | 146.9 | 81.4 | 28 | 199.4 | 110.5 | 88 | 251.9 | 139.6 |
| 49 | 42.9 | 23.8 | 09 | 95.3 | 52.8 | 69 | 147.8 | 81.9 | 29 | 200.3 | 111.0 | 89 | 252.8 | 140.1 |
| 50 | 43.7 | 24.2 | 10 | 96.2 | 53.3 | 70 | 148.7 | 82.4 | 30 | 201.2 | 111.5 | 90 | 253.6 | 140.6 |
| 51 | 44.6 | 24.7 | 111 | 97.1 | 53.8 | 171 | 149.6 | 82.9 | 231 | 202.0 | 112.0 | 291 | 254.5 | 141.1 |
| 52 | 45.5 | 25.2 | 12 | 98.0 | 54.3 | 72 | 150.4 | 83.4 | 32 | 202.9 | 112.5 | 92 | 255.4 | 141.6 |
| 53 | 46.4 | 25.7 | 13 | 98.8 | 54.8 | 73 | 151.3 | 83.9 | 33 | 203.8 | 113.0 | 93 | 256.3 | 142.0 |
| 54 | 47.2 | 26.2 | 14 | 99.7 | 55.3 | 74 | 152.2 | 84.4 | 34 | 204.7 | 113.4 | 94 | 257.1 | 142.5 |
| 55 | 48.1 | 26.7 | 15 | 100.6 | 55.8 | 75 | 153.1 | 84.8 | 35 | 205.5 | 113.9 | 95 | 258.0 | 143.0 |
| 56 | 49.0 | 27.1 | 16 | 101.5 | 56.2 | 76 | 153.9 | 85.3 | 36 | 206.4 | 114.4 | 96 | 258.9 | 143.5 |
| 57 | 49.9 | 27.6 | 17 | 102.3 | 56.7 | 77 | 154.8 | 85.8 | 37 | 207.3 | 114.9 | 97 | 259.8 | 144.0 |
| 58 | 50.7 | 28.1 | 18 | 103.2 | 57.2 | 78 | 155.7 | 86.3 | 38 | 208.2 | 115.4 | 98 | 260.6 | 144.5 |
| 59 | 51.6 | 28.6 | 19 | 104.1 | 57.7 | 79 | 156.6 | 86.8 | 39 | 209.0 | 115.9 | 99 | 261.5 | 145.0 |
| 60 | 52.5 | 29.1 | 20 | 105.0 | 58.2 | 80 | 157.4 | 87.3 | 40 | 209.9 | 116.4 | 300 | 262.4 | 145.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

61° (119°, 241°, 299°).

## TABLE 2. [Page 425

Difference of Latitude and Departure for 29° (151°, 209°, 331°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 263.2 | 145.9 | 361 | 315.7 | 175.0 | 421 | 368.2 | 204.1 | 481 | 420.7 | 233.2 | 541 | 473.2 | 262.3 |
| 02 | 264.1 | 146.4 | 62 | 316.6 | 175.5 | 22 | 369.1 | 204.6 | 82 | 421.5 | 233.7 | 42 | 474.0 | 262.8 |
| 03 | 265.0 | 146.9 | 63 | 317.5 | 176.0 | 23 | 369.9 | 205.1 | 83 | 422.4 | 234.2 | 43 | 474.9 | 263.2 |
| 04 | 265.9 | 147.4 | 64 | 318.3 | 176.5 | 24 | 370.8 | 205.6 | 84 | 423.3 | 234.6 | 44 | 475.8 | 263.7 |
| 05 | 266.7 | 147.9 | 65 | 319.2 | 177.0 | 25 | 371.7 | 206.0 | 85 | 424.2 | 235.1 | 45 | 476.6 | 264.2 |
| 06 | 267.6 | 148.4 | 66 | 320.1 | 177.4 | 26 | 372.6 | 206.5 | 86 | 425.0 | 235.6 | 46 | 477.5 | 264.7 |
| 07 | 268.5 | 148.8 | 67 | 321.0 | 177.9 | 27 | 373.4 | 207.0 | 87 | 425.9 | 236.1 | 47 | 478.4 | 265.2 |
| 08 | 269.4 | 149.3 | 68 | 321.8 | 178.4 | 28 | 374.3 | 207.5 | 88 | 426.8 | 236.6 | 48 | 479.3 | 265.7 |
| 09 | 270.2 | 149.8 | 69 | 322.7 | 178.9 | 29 | 375.2 | 208.0 | 89 | 427.7 | 237.1 | 49 | 480.1 | 266.2 |
| 10 | 271.1 | 150.3 | 70 | 323.6 | 179.4 | 30 | 376.1 | 208.5 | 90 | 428.5 | 237.6 | 50 | 481.0 | 266.6 |
| 311 | 272.0 | 150.8 | 371 | 324.5 | 179.9 | 431 | 376.9 | 209.0 | 491 | 429.4 | 238.0 | 551 | 481.9 | 267.1 |
| 12 | 272.9 | 151.3 | 72 | 325.3 | 180.4 | 32 | 377.8 | 209.4 | 92 | 430.3 | 238.5 | 52 | 482.8 | 267.6 |
| 13 | 273.7 | 151.7 | 73 | 326.2 | 180.8 | 33 | 378.7 | 209.9 | 93 | 431.2 | 239.0 | 53 | 483.6 | 268.1 |
| 14 | 274.6 | 152.2 | 74 | 327.1 | 181.3 | 34 | 379.6 | 210.4 | 94 | 432.0 | 239.5 | 54 | 484.5 | 268.6 |
| 15 | 275.5 | 152.7 | 75 | 328.0 | 181.8 | 35 | 380.4 | 210.9 | 95 | 432.9 | 240.0 | 55 | 485.4 | 269.1 |
| 16 | 276.3 | 153.2 | 76 | 328.8 | 182.3 | 36 | 381.3 | 211.4 | 96 | 433.8 | 240.5 | 56 | 486.3 | 269.5 |
| 17 | 277.2 | 153.7 | 77 | 329.7 | 182.8 | 37 | 382.2 | 211.9 | 97 | 434.7 | 240.9 | 57 | 487.1 | 270.0 |
| 18 | 278.1 | 154.2 | 78 | 230.6 | 183.3 | 38 | 383.1 | 212.3 | 98 | 435.5 | 241.4 | 58 | 488.0 | 270.5 |
| 19 | 279.0 | 154.7 | 79 | 331.4 | 183.7 | 39 | 383.9 | 212.8 | 99 | 436.4 | 241.9 | 59 | 488.9 | 271.0 |
| 20 | 279.8 | 155.1 | 80 | 332.3 | 184.2 | 40 | 384.8 | 213.3 | 500 | 437.3 | 242.4 | 60 | 489.8 | 271.5 |
| 321 | 280.7 | 155.6 | 381 | 333.2 | 184.7 | 441 | 385.7 | 213.8 | 501 | 438.2 | 242.9 | 561 | 490.6 | 272.0 |
| 22 | 281.6 | 156.1 | 82 | 334.1 | 185.2 | 42 | 386.6 | 214.3 | 02 | 439.0 | 243.4 | 62 | 491.5 | 272.5 |
| 23 | 282.5 | 156.6 | 83 | 334.9 | 185.7 | 43 | 387.4 | 214.8 | 03 | 439.9 | 243.9 | 63 | 492.4 | 272.9 |
| 24 | 283.3 | 157.1 | 84 | 335.8 | 186.2 | 44 | 388.3 | 215.3 | 04 | 440.8 | 244.3 | 64 | 493.2 | 273.4 |
| 25 | 284.2 | 157.6 | 85 | 336.7 | 186.7 | 45 | 389.2 | 215.7 | 05 | 441.6 | 244.8 | 65 | 494.1 | 273.9 |
| 26 | 285.1 | 158.1 | 86 | 337.6 | 187.1 | 46 | 390.0 | 216.2 | 06 | 442.5 | 245.3 | 66 | 495.0 | 274.4 |
| 27 | 286.0 | 158.5 | 87 | 338.4 | 187.6 | 47 | 390.9 | 216.7 | 07 | 443.4 | 245.8 | 67 | 495.9 | 274.9 |
| 28 | 286.8 | 159.0 | 88 | 339.3 | 188.1 | 48 | 391.8 | 217.2 | 08 | 444.3 | 246.3 | 68 | 496.8 | 275.4 |
| 29 | 287.7 | 159.5 | 89 | 340.2 | 188.6 | 49 | 392.7 | 217.7 | 09 | 445.2 | 246.8 | 69 | 497.7 | 275.9 |
| 30 | 288.6 | 160.0 | 90 | 341.1 | 189.1 | 50 | 393.5 | 218.2 | 10 | 446.1 | 247.3 | 70 | 498.5 | 276.3 |
| 31 | 289.5 | 160.5 | 391 | 341.9 | 189.6 | 451 | 394.4 | 218.7 | 511 | 447.0 | 247.8 | 571 | 499.4 | 276.8 |
| 32 | 290.3 | 161.0 | 92 | 342.8 | 190.0 | 52 | 395.3 | 219.1 | 12 | 447.8 | 248.2 | 72 | 500.3 | 277.3 |
| 33 | 291.2 | 161.4 | 93 | 343.7 | 190.5 | 53 | 396.2 | 219.6 | 13 | 448.6 | 248.7 | 73 | 501.1 | 277.8 |
| 34 | 292.1 | 161.9 | 94 | 344.6 | 191.0 | 54 | 397.0 | 220.1 | 14 | 449.5 | 249.2 | 74 | 502.0 | 278.3 |
| 35 | 293.0 | 162.4 | 95 | 345.4 | 191.5 | 55 | 397.9 | 220.6 | 15 | 450.4 | 249.7 | 75 | 502.9 | 278.8 |
| 36 | 293.8 | 162.9 | 96 | 346.3 | 192.0 | 56 | 398.8 | 221.1 | 16 | 451.3 | 250.2 | 76 | 503.7 | 279.2 |
| 37 | 294.7 | 163.4 | 97 | 347.2 | 192.5 | 57 | 399.7 | 221.6 | 17 | 452.2 | 250.6 | 77 | 504.6 | 279.7 |
| 38 | 295.6 | 163.9 | 98 | 348.1 | 193.0 | 58 | 400.5 | 222.0 | 18 | 453.1 | 251.1 | 78 | 505.5 | 280.2 |
| 39 | 296.5 | 164.4 | 99 | 348.9 | 193.4 | 59 | 401.4 | 222.5 | 19 | 453.9 | 251.6 | 79 | 506.4 | 280.7 |
| 40 | 297.3 | 164.8 | 400 | 349.8 | 193.9 | 60 | 402.3 | 223.0 | 20 | 454.8 | 252.1 | 80 | 507.2 | 281.2 |
| 341 | 298.2 | 165.3 | 401 | 350.7 | 194.4 | 461 | 403.2 | 223.5 | 521 | 455.6 | 252.6 | 581 | 508.1 | 281.7 |
| 42 | 299.1 | 165.8 | 02 | 351.6 | 194.9 | 62 | 404.0 | 224.0 | 22 | 456.5 | 253.1 | 82 | 509.0 | 282.2 |
| 43 | 300.0 | 166.3 | 03 | 352.4 | 195.4 | 63 | 404.9 | 224.5 | 23 | 457.4 | 253.6 | 83 | 509.9 | 282.7 |
| 44 | 300.8 | 166.8 | 04 | 353.3 | 195.9 | 64 | 405.8 | 225.0 | 24 | 458.3 | 254.0 | 84 | 510.7 | 283.2 |
| 45 | 301.7 | 167.3 | 05 | 354.2 | 196.3 | 65 | 406.7 | 225.4 | 25 | 459.1 | 254.5 | 85 | 511.6 | 283.6 |
| 46 | 302.6 | 167.7 | 06 | 355.1 | 196.8 | 66 | 407.5 | 225.9 | 26 | 460.0 | 255.0 | 86 | 512.5 | 284.1 |
| 47 | 303.5 | 168.2 | 07 | 355.9 | 197.3 | 67 | 408.4 | 226.4 | 27 | 460.9 | 255.5 | 87 | 513.4 | 284.6 |
| 48 | 304.3 | 168.7 | 08 | 356.8 | 197.8 | 68 | 409.3 | 226.9 | 28 | 461.8 | 256.0 | 88 | 514.3 | 285.0 |
| 49 | 305.2 | 169.2 | 09 | 357.7 | 198.3 | 69 | 410.2 | 227.4 | 29 | 462.6 | 256.5 | 89 | 515.1 | 285.5 |
| 50 | 306.1 | 169.7 | 10 | 358.6 | 198.8 | 70 | 411.0 | 227.9 | 30 | 463.5 | 256.9 | 90 | 516.0 | 286.0 |
| 351 | 307.0 | 170.2 | 411 | 359.4 | 199.3 | 471 | 411.9 | 228.3 | 531 | 464.4 | 257.4 | 591 | 516.9 | 286.5 |
| 52 | 307.8 | 170.7 | 12 | 360.3 | 199.7 | 72 | 412.8 | 228.8 | 32 | 465.3 | 257.9 | 92 | 517.7 | 287.0 |
| 53 | 308.7 | 171.1 | 13 | 361.2 | 200.2 | 73 | 413.7 | 229.3 | 33 | 466.1 | 258.4 | 93 | 518.6 | 287.5 |
| 54 | 309.6 | 171.6 | 14 | 362.1 | 200.7 | 74 | 414.5 | 229.8 | 34 | 467.0 | 258.9 | 94 | 519.5 | 288.0 |
| 55 | 310.5 | 172.1 | 15 | 362.9 | 201.2 | 75 | 415.4 | 230.3 | 35 | 467.9 | 259.4 | 95 | 520.4 | 288.5 |
| 56 | 311.3 | 172.6 | 16 | 363.8 | 201.7 | 76 | 416.3 | 230.8 | 36 | 468.8 | 259.9 | 96 | 521.2 | 289.0 |
| 57 | 312.2 | 173.1 | 17 | 364.7 | 202.2 | 77 | 417.2 | 231.3 | 37 | 469.6 | 260.3 | 97 | 522.1 | 289.4 |
| 58 | 313.1 | 173.6 | 18 | 365.6 | 202.7 | 78 | 418.0 | 231.7 | 38 | 470.5 | 260.8 | 98 | 523.0 | 289.9 |
| 59 | 314.0 | 174.0 | 19 | 366.4 | 203.1 | 79 | 418.9 | 232.2 | 39 | 471.4 | 261.3 | 99 | 523.9 | 290.4 |
| 60 | 314.8 | 174.5 | 20 | 367.3 | 203.6 | 80 | 419.8 | 232.7 | 40 | 472.3 | 261.8 | 600 | 524.8 | 290.9 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

61° (119°, 241°, 299°).

# TABLE 2.

### Difference of Latitude and Departure for 30° (150°, 210°, 330°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | °0.5 | 61 | 52.8 | 30.5 | 121 | 104.8 | 60.5 | 181 | 156.8 | 90.5 | 241 | 208.7 | 120.5 |
| 2 | 1.7 | 1.0 | 62 | 53.7 | 31.0 | 22 | 105.7 | 61.0 | 82 | 157.6 | 91.0 | 42 | 209.6 | 121.0 |
| 3 | 2.6 | 1.5 | 63 | 54.6 | 31.5 | 23 | 106.5 | 61.5 | 83 | 158.5 | 91.5 | 43 | 210.4 | 121.5 |
| 4 | 3.5 | 2.0 | 64 | 55.4 | 32.0 | 24 | 107.4 | 62.0 | 84 | 159.3 | 92.0 | 44 | 211.3 | 122.0 |
| 5 | 4.3 | 2.5 | 65 | 56.3 | 32.5 | 25 | 108.3 | 62.5 | 85 | 160.2 | 92.5 | 45 | 212.2 | 122.5 |
| 6 | 5.2 | 3.0 | 66 | 57.2 | 33.0 | 26 | 109.1 | 63.0 | 86 | 161.1 | 93.0 | 46 | 213.0 | 123.0 |
| 7 | 6.1 | 3.5 | 67 | 58.0 | 33.5 | 27 | 110.0 | 63.5 | 87 | 161.9 | 93.5 | 47 | 213.9 | 123.5 |
| 8 | 6.9 | 4.0 | 68 | 58.9 | 34.0 | 28 | 110.9 | 64.0 | 88 | 162.8 | 94.0 | 48 | 214.8 | 124.0 |
| 9 | 7.8 | 4.5 | 69 | 59.8 | 34.5 | 29 | 111.7 | 64.5 | 89 | 163.7 | 94.5 | 49 | 215.6 | 124.5 |
| 10 | 8.7 | 5.0 | 70 | 60.6 | 35.0 | 30 | 112.6 | 65.0 | 90 | 164.5 | 95.0 | 50 | 216.5 | 125.0 |
| 11 | 9.5 | 5.5 | 71 | 61.5 | 35.5 | 131 | 113.4 | 65.5 | 191 | 165.4 | 95.5 | 251 | 217.4 | 125.5 |
| 12 | 10.4 | 6.0 | 72 | 62.4 | 36.0 | 32 | 114.3 | 66.0 | 92 | 166.3 | 96.0 | 52 | 218.2 | 126.0 |
| 13 | 11.3 | 6.5 | 73 | 63.2 | 36.5 | 33 | 115.2 | 66.5 | 93 | 167.1 | 96.5 | 53 | 219.1 | 126.5 |
| 14 | 12.1 | 7.0 | 74 | 64.1 | 37.0 | 34 | 116.0 | 67.0 | 94 | 168.0 | 97.0 | 54 | 220.0 | 127.0 |
| 15 | 13.0 | 7.5 | 75 | 65.0 | 37.5 | 35 | 116.9 | 67.5 | 95 | 168.9 | 97.5 | 55 | 220.8 | 127.5 |
| 16 | 13.9 | 8.0 | 76 | 65.8 | 38.0 | 36 | 117.8 | 68.0 | 96 | 169.7 | 98.0 | 56 | 221.7 | 128.0 |
| 17 | 14.7 | 8.5 | 77 | 66.7 | 38.5 | 37 | 118.6 | 68.5 | 97 | 170.6 | 98.5 | 57 | 222.6 | 128.5 |
| 18 | 15.6 | 9.0 | 78 | 67.5 | 39.0 | 38 | 119.5 | 69.0 | 98 | 171.5 | 99.0 | 58 | 223.4 | 129.0 |
| 19 | 16.5 | 9.5 | 79 | 68.4 | 39.5 | 39 | 120.4 | 69.5 | 99 | 172.3 | 99.5 | 59 | 224.3 | 129.5 |
| 20 | 17.3 | 10.0 | 80 | 69.3 | 40.0 | 40 | 121.2 | 70.0 | 200 | 173.2 | 100.0 | 60 | 225.2 | 130.0 |
| 21 | 18.2 | 10.5 | 81 | 70.1 | 40.5 | 141 | 122.1 | 70.5 | 201 | 174.1 | 100.5 | 261 | 226.0 | 130.5 |
| 22 | 19.1 | 11.0 | 82 | 71.0 | 41.0 | 42 | 123.0 | 71.0 | 02 | 174.9 | 101.0 | 62 | 226.9 | 131.0 |
| 23 | 19.9 | 11.5 | 83 | 71.9 | 41.5 | 43 | 123.8 | 71.5 | 03 | 175.8 | 101.5 | 63 | 227.8 | 131.5 |
| 24 | 20.8 | 12.0 | 84 | 72.7 | 42.0 | 44 | 124.7 | 72.0 | 04 | 176.7 | 102.0 | 64 | 228.6 | 132.0 |
| 25 | 21.7 | 12.5 | 85 | 73.6 | 42.5 | 45 | 125.6 | 72.5 | 05 | 177.5 | 102.5 | 65 | 229.5 | 132.5 |
| 26 | 22.5 | 13.0 | 86 | 74.5 | 43.0 | 46 | 126.4 | 73.0 | 06 | 178.4 | 103.0 | 66 | 230.4 | 133.0 |
| 27 | 23.4 | 13.5 | 87 | 75.3 | 43.5 | 47 | 127.3 | 73.5 | 07 | 179.3 | 103.5 | 67 | 231.2 | 133.5 |
| 28 | 24.2 | 14.0 | 88 | 76.2 | 44.0 | 48 | 128.2 | 74.0 | 08 | 180.1 | 104.0 | 68 | 232.1 | 134.0 |
| 29 | 25.1 | 14.5 | 89 | 77.1 | 44.5 | 49 | 129.0 | 74.5 | 09 | 181.0 | 104.5 | 69 | 233.0 | 134.5 |
| 30 | 26.0 | 15.0 | 90 | 77.9 | 45.0 | 50 | 129.9 | 75.0 | 10 | 181.9 | 105.0 | 70 | 233.8 | 135.0 |
| 31 | 26.8 | 15.5 | 91 | 78.8 | 45.5 | 151 | 130.8 | 75.5 | 211 | 182.7 | 105.5 | 271 | 234.7 | 135.5 |
| 32 | 27.7 | 16.0 | 92 | 79.7 | 46.0 | 52 | 131.6 | 76.0 | 12 | 183.6 | 106.0 | 72 | 235.6 | 136.0 |
| 33 | 28.6 | 16.5 | 93 | 80.5 | 46.5 | 53 | 132.5 | 76.5 | 13 | 184.5 | 106.5 | 73 | 236.4 | 136.5 |
| 34 | 29.4 | 17.0 | 94 | 81.4 | 47.0 | 54 | 133.4 | 77.0 | 14 | 185.3 | 107.0 | 74 | 237.3 | 137.0 |
| 35 | 30.3 | 17.5 | 95 | 82.3 | 47.5 | 55 | 134.2 | 77.5 | 15 | 186.2 | 107.5 | 75 | 238.2 | 137.5 |
| 36 | 31.2 | 18.0 | 96 | 83.1 | 48.0 | 56 | 135.1 | 78.0 | 16 | 187.1 | 108.0 | 76 | 239.0 | 138.0 |
| 37 | 32.0 | 18.5 | 97 | 84.0 | 48.5 | 57 | 136.0 | 78.5 | 17 | 187.9 | 108.5 | 77 | 239.9 | 138.5 |
| 38 | 32.9 | 19.0 | 98 | 84.9 | 49.0 | 58 | 136.8 | 79.0 | 18 | 188.8 | 109.0 | 78 | 240.8 | 139.0 |
| 39 | 33.8 | 19.5 | 99 | 85.7 | 49.5 | 59 | 137.7 | 79.5 | 19 | 189.7 | 109.5 | 79 | 241.6 | 139.5 |
| 40 | 34.6 | 20.0 | 100 | 86.6 | 50.0 | 60 | 138.6 | 80.0 | 20 | 190.5 | 110.0 | 80 | 242.5 | 140.0 |
| 41 | 35.5 | 20.5 | 101 | 87.5 | 50.5 | 161 | 139.4 | 80.5 | 221 | 191.4 | 110.5 | 281 | 243.4 | 140.5 |
| 42 | 36.4 | 21.0 | 02 | 88.3 | 51.0 | 62 | 140.3 | 81.0 | 22 | 192.3 | 111.0 | 82 | 244.2 | 141.0 |
| 43 | 37.2 | 21.5 | 03 | 89.2 | 51.5 | 63 | 141.2 | 81.5 | 23 | 193.1 | 111.5 | 83 | 245.1 | 141.5 |
| 44 | 38.1 | 22.0 | 04 | 90.1 | 52.0 | 64 | 142.0 | 82.0 | 24 | 194.0 | 112.0 | 84 | 246.0 | 142.0 |
| 45 | 39.0 | 22.5 | 05 | 90.9 | 52.5 | 65 | 142.9 | 82.5 | 25 | 194.9 | 112.5 | 85 | 246.8 | 142.5 |
| 46 | 39.8 | 23.0 | 06 | 91.8 | 53.0 | 66 | 143.8 | 83.0 | 26 | 195.7 | 113.0 | 86 | 247.7 | 143.0 |
| 47 | 40.7 | 23.5 | 07 | 92.7 | 53.5 | 67 | 144.6 | 83.5 | 27 | 196.6 | 113.5 | 87 | 248.5 | 143.5 |
| 48 | 41.6 | 24.0 | 08 | 93.5 | 54.0 | 68 | 145.5 | 84.0 | 28 | 197.5 | 114.0 | 88 | 249.4 | 144.0 |
| 49 | 42.4 | 24.5 | 09 | 94.4 | 54.5 | 69 | 146.4 | 84.5 | 29 | 198.3 | 114.5 | 89 | 250.3 | 144.5 |
| 50 | 43.3 | 25.0 | 10 | 95.3 | 55.0 | 70 | 147.2 | 85.0 | 30 | 199.2 | 115.0 | 90 | 251.1 | 145.0 |
| 51 | 44.2 | 25.5 | 111 | 96.1 | 55.5 | 171 | 148.1 | 85.5 | 231 | 200.1 | 115.5 | 291 | 252.0 | 145.5 |
| 52 | 45.0 | 26.0 | 12 | 97.0 | 56.0 | 72 | 149.0 | 86.0 | 32 | 200.9 | 116.0 | 92 | 252.9 | 146.0 |
| 53 | 45.9 | 26.5 | 13 | 97.9 | 56.5 | 73 | 149.8 | 86.5 | 33 | 201.8 | 116.5 | 93 | 253.7 | 146.5 |
| 54 | 46.8 | 27.0 | 14 | 98.7 | 57.0 | 74 | 150.7 | 87.0 | 34 | 202.6 | 117.0 | 94 | 254.6 | 147.0 |
| 55 | 47.6 | 27.5 | 15 | 99.6 | 57.5 | 75 | 151.6 | 87.5 | 35 | 203.5 | 117.5 | 95 | 255.5 | 147.5 |
| 56 | 48.5 | 28.0 | 16 | 100.5 | 58.0 | 76 | 152.4 | 88.0 | 36 | 204.4 | 118.0 | 96 | 256.3 | 148.0 |
| 57 | 49.4 | 28.5 | 17 | 101.3 | 58.5 | 77 | 153.3 | 88.5 | 37 | 205.2 | 118.5 | 97 | 257.2 | 148.5 |
| 58 | 50.2 | 29.0 | 18 | 102.2 | 59.0 | 78 | 154.2 | 89.0 | 38 | 206.1 | 119.0 | 98 | 258.1 | 149.0 |
| 59 | 51.1 | 29.5 | 19 | 103.1 | 59.5 | 79 | 155.0 | 89.5 | 39 | 207.0 | 119.5 | 99 | 258.9 | 149.5 |
| 60 | 52.0 | 30.0 | 20 | 103.9 | 60.0 | 80 | 155.9 | 90.0 | 40 | 207.8 | 120.0 | 300 | 259.8 | 150.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 60° (120°, 240°, 300°).

TABLE 2. [Page 427

Difference of Latitude and Departure for 30° (150°, 210°, 330°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 260.7 | 150.5 | 361 | 312.6 | 180.5 | 421 | 364.6 | 210.5 | 481 | 416.6 | 240.5 | 541 | 468.5 | 270.5 |
| 02 | 261.5 | 151.0 | 62 | 313.5 | 181.0 | 22 | 365.5 | 211.0 | 82 | 417.4 | 241.0 | 42 | 469.4 | 271.0 |
| 03 | 262.4 | 151.5 | 63 | 314.4 | 181.5 | 23 | 366.3 | 211.5 | 83 | 418.3 | 241.5 | 43 | 470.3 | 271.5 |
| 04 | 263.3 | 152.0 | 64 | 315.2 | 182.0 | 24 | 367.2 | 212.0 | 84 | 419.2 | 242.0 | 44 | 471.1 | 272.0 |
| 05 | 264.1 | 152.5 | 65 | 316.1 | 182.5 | 25 | 368.1 | 212.5 | 85 | 420.0 | 242.5 | 45 | 472.0 | 272.5 |
| 06 | 265.0 | 153.0 | 66 | 317.0 | 183.0 | 26 | 368.9 | 213.0 | 86 | 420.9 | 243.0 | 46 | 472.9 | 273.0 |
| 07 | 265.9 | 153.5 | 67 | 317.8 | 183.5 | 27 | 369.8 | 213.5 | 87 | 421.8 | 243.5 | 47 | 473.7 | 273.5 |
| 08 | 266.7 | 154.0 | 68 | 318.7 | 184.0 | 28 | 370.7 | 214.0 | 88 | 422.6 | 244.0 | 48 | 474.6 | 274.0 |
| 09 | 267.6 | 154.5 | 69 | 319.6 | 184.5 | 29 | 371.5 | 214.5 | 89 | 423.5 | 244.5 | 49 | 475.5 | 274.5 |
| 10· | 268.5 | 155.0 | 70 | 320.4 | 185.0 | 30 | 372.4 | 215.0 | 90 | 424.4 | 245.0 | 50 | 476.3 | 275.0 |
| 311 | 269.3 | 155.5 | 371 | 321.3 | 185.5 | 431 | 373.3 | 215.5 | 491 | 425.2 | 245.5 | 551 | 477.2 | 275.5 |
| 12 | 270.2 | 156.0 | 72 | 322.2 | 186.0 | 32 | 374.1 | 216.0 | 92 | 426.1 | 246.0 | 52 | 478.1 | 276.0 |
| 13 | 271.1 | 156.5 | 73 | 323.0 | 186.5 | 33 | 375.0 | 216.5 | 93 | 426.9 | 246.5 | 53 | 478.9 | 276.5 |
| 14 | 271.9 | 157.0 | 74 | 323.9 | 187.0 | 34 | 375.9 | 217.0 | 94 | 427.8 | 247.0 | 54 | 479.8 | 277.0 |
| 15 | 272.8 | 157.5 | 75 | 324.8 | 187.5 | 35 | 376.7 | 217.5 | 95 | 428.7 | 247.5 | 55 | 480.7 | 277.5 |
| 16 | 273.7 | 158.0 | 76 | 325.6 | 188.0 | 36 | 377.6 | 218.0 | 96 | 429.6 | 248.0 | 56 | 481.5 | 278.0 |
| 17 | 274.5 | 158.5 | 77 | 326.5 | 188.5 | 37 | 378.5 | 218.5 | 97 | 430.4 | 248.5 | 57 | 482.4 | 278.5 |
| 18 | 275.4 | 159.0 | 78 | 327.4 | 189.0 | 38 | 379.3 | 219.0 | 98 | 431.3 | 249.0 | 58 | 483.3 | 279.0 |
| 19 | 276.3 | 159.5 | 79 | 328.2 | 189.5 | 39 | 380.2 | 219.5 | 99 | 432.2 | 249.5 | 59 | 484.1 | 279.5 |
| 20 | 277.1 | 160.0 | 80 | 329.1 | 190.0 | 40 | 381.1 | 220.0 | 500 | 433.0 | 250.0 | 60 | 485.0 | 280.0 |
| 321 | 278.0 | 160.5 | 381 | 330.0 | 190.5 | 441 | 381.9 | 220.5 | 501 | 433.9 | 250.5 | 561 | 485.9 | 280.5 |
| 22 | 278.9 | 161.0 | 82 | 330.8 | 191.0 | 42 | 382.8 | 221.0 | 02 | 434.8 | 251.0 | 62 | 486.7 | 281.0 |
| 23 | 279.7 | 161.5 | 83 | 331.7 | 191.5 | 43 | 383.7 | 221.5 | 03 | 435.6 | 251.5 | 63 | 487.6 | 281.5 |
| 24 | 280.6 | 162.0 | 84 | 332.6 | 192.0 | 44 | 384.5 | 222.0 | 04 | 436.5 | 252.0 | 64 | 488.5 | 282.0 |
| 25 | 281.5 | 162.5 | 85 | 333.4 | 192.5 | 45 | 385.4 | 222.5 | 05 | 437.4 | 252.5 | 65 | 489.3 | 282.5 |
| 26 | 282.3 | 163.0 | 86 | 334.3 | 193.0 | 46 | 386.3 | 223.0 | 06 | 438.2 | 253.0 | 66 | 490.2 | 283.0 |
| 27 | 283.2 | 163.5 | 87 | 335.2 | 193.5 | 47 | 387.1 | 223.5 | 07 | 439.1 | 253.5 | 67 | 491.1 | 283.5 |
| 28 | 284.1 | 164.0 | 88 | 336.0 | 194.0 | 48 | 388.0 | 224.0 | 08 | 440.0 | 254.0 | 68 | 491.9 | 284.0 |
| 29 | 284.9 | 164.5 | 89 | 336.9 | 194.5 | 49 | 388.9 | 224.5 | 09 | 440.8 | 254.5 | 69 | 492.8 | 284.5 |
| 30 | 285.8 | 165.0 | 90 | 337.8 | 195.0 | 50 | 389.7 | 225.0 | 10 | 441.7 | 255.0 | 70 | 493.6 | 285.0 |
| 331 | 286.7 | 165.5 | 391 | 338.6 | 195.5 | 451 | 390.6 | 225.5 | 511 | 442.6 | 255.5 | 571 | 494.5 | 285.5 |
| 32 | 287.5 | 166.0 | 92 | 339.5 | 196.0 | 52 | 391.5 | 226.0 | 12 | 443.4 | 256.0 | 72 | 495.4 | 286.0 |
| 33 | 288.4 | 166.5 | 93 | 340.4 | 196.5 | 53 | 392.3 | 226.5 | 13 | 444.3 | 256.5 | 73 | 496.3 | 286.5 |
| 34 | 289.3 | 167.0 | 94 | 341.2 | 197.0 | 54 | 393.2 | 227.0 | 14 | 445.2 | 257.0 | 74 | 497.1 | 287.0 |
| 35 | 290.1 | 167.5 | 95 | 342.1 | 197.5 | 55 | 394.0 | 227.5 | 15 | 446.0 | 257.5 | 75 | 497.9 | 287.5 |
| 36 | 291.0 | 168.0 | 96 | 343.0 | 198.0 | 56 | 394.9 | 228.0 | 16 | 446.9 | 258.0 | 76 | 498.8 | 288.0 |
| 37 | 291.9 | 168.5 | 97 | 343.8 | 198.5 | 57 | 395.8 | 228.5 | 17 | 447.8 | 258.5 | 77 | 499.7 | 288.5 |
| 38 | 292.7 | 169.0 | 98 | 344.7 | 199.0 | 58 | 396.6 | 229.0 | 18 | 448.6 | 259.0 | 78 | 500.5 | 289.0 |
| 39 | 293.6 | 169.5 | 99 | 345.6 | 199.5 | 59 | 397.5 | 229.5 | 19 | 449.4 | 259.5 | 79 | 501.3 | 289.5 |
| 40 | 294.5 | 170.0 | 400 | 346.4 | 200.0 | 60 | 398.4 | 230.0 | 20 | 450.3 | 260.0 | 80 | 502.2 | 290.0 |
| 341 | 295.3 | 170.5 | 401 | 347.3 | 200.5 | 461 | 399.2 | 230.5 | 521 | 451.2 | 260.5 | 581 | 503.1 | 290.5 |
| 42 | 296.2 | 171.0 | 02 | 348.1 | 201.0 | 62 | 400.1 | 231.0 | 22 | 452.1 | 261.0 | 82 | 504.0 | 291.0 |
| 43 | 297.1 | 171.5 | 03 | 349.0 | 201.5 | 63 | 401.0 | 231.5 | 23 | 452.9 | 261.5 | 83 | 504.9 | 291.5 |
| 44 | 297.9 | 172.0 | 04 | 349.9 | 202.0 | 64 | 401.8 | 232.0 | 24 | 453.8 | 262.0 | 84 | 505.8 | 292.0 |
| 45 | 298.8 | 172.5 | 05 | 350.7 | 202.5 | 65 | 402.7 | 232.5 | 25 | 454.7 | 262.5 | 85 | 506.6 | 292.5 |
| 46 | 299.7 | 173.0 | 06 | 351.6 | 203.0 | 66 | 403.6 | 233.0 | 26 | 455.5 | 263.0 | 86 | 507.5 | 293.0 |
| 47 | 300.5 | 173.5 | 07 | 352.5 | 203.5 | 67 | 404.4 | 233.5 | 27 | 456.4 | 263.5 | 87 | 508.4 | 293.5 |
| 48 | 301.4 | 174.0 | 08 | 353.3 | 204.0 | 68 | 405.3 | 234.0 | 28 | 457.3 | 264.0 | 88 | 509.2 | 294.0 |
| 49 | 302.3 | 174.5 | 09 | 354.2 | 204.5 | 69 | 406.2 | 234.5 | 29 | 458.1 | 264.5 | 89 | 510.1 | 294.5 |
| 50 | 303.1 | 175.0 | 10 | 355.1 | 205.0 | 70 | 407.0 | 235.0 | 30 | 459.0 | 265.0 | 90 | 511.0 | 295.0 |
| 351 | 304.0 | 175.5 | 411 | 355.9 | 205.5 | 471 | 407.9 | 235.5 | 531 | 459.9 | 265.5 | 591 | 511.8 | 295.5 |
| 52 | 304.8 | 176.0 | 12 | 356.8 | 206.0 | 72 | 408.8 | 236.0 | 32 | 460.7 | 266.0 | 92 | 512.7 | 296.0 |
| 53 | 305.7 | 176.5 | 13 | 357.7 | 206.5 | 73 | 409.6 | 236.5 | 33 | 461.6 | 266.5 | 93 | 513.6 | 296.5 |
| 54 | 306.6 | 177.0 | 14 | 358.5 | 207.0 | 74 | 410.5 | 237.0 | 34 | 462.5 | 267.0 | 94 | 514.4 | 297.0 |
| 55 | 307.4 | 177.5 | 15 | 359.4 | 207.5 | 75 | 411.4 | 237.5 | 35 | 463.3 | 267.5 | 95 | 515.3 | 297.5 |
| 56 | 308.3 | 178.0 | 16 | 360.3 | 208.0 | 76 | 412.2 | 238.0 | 36 | 464.2 | 268.0 | 96 | 516.2 | 298.0 |
| 57 | 309.2 | 178.5 | 17 | 361.1 | 208.5 | 77 | 413.1 | 238.5 | 37 | 465.1 | 268.5 | 97 | 517.0 | 298.5 |
| 58 | 310.0 | 179.0 | 18 | 362.0 | 209.0 | 78 | 414.0 | 239.0 | 38 | 465.9 | 269.0 | 98 | 517.9 | 299.0 |
| 59 | 310.9 | 179.5 | 19 | 362.9 | 209.5 | 79 | 414.8 | 239.5 | 39 | 466.8 | 269.5 | 99 | 518.8 | 299.5 |
| 60 | 311.8 | 180.0 | 20 | 363.7 | 210.0 | 80 | 415.7 | 240.0 | 40 | 467.7 | 270.0 | 600 | 519.6 | 300.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

60° (120°, 240°, 300°).

# TABLE 2.

Difference of Latitude and Departure for 31° (149°, 211°, 329°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.9 | 0.5 | 61 | 52.3 | 31.4 | 121 | 103.7 | 62.3 | 181 | 155.1 | 93.2 | 241 | 206.6 | 124.1 |
| 2 | 1.7 | 1.0 | 62 | 53.1 | 31.9 | 22 | 104.6 | 62.8 | 82 | 156.0 | 93.7 | 42 | 207.4 | 124.6 |
| 3 | 2.6 | 1.5 | 63 | 54 0 | 32.4 | 23 | 105.4 | 63.3 | 83 | 156.9 | 94.3 | 43 | 208.3 | 125.2 |
| 4 | 3.4 | 2.1 | 64 | 54.9 | 33.0 | 24 | 106.3 | 63.9 | 84 | 157.7 | 94.8 | 44 | 209.1 | 125.7 |
| 5 | 4.3 | 2.6 | 65 | 55.7 | 33.5 | 25 | 107.1 | 64.4 | 85 | 158.6 | 95.3 | 45 | 210.0 | 126.2 |
| 6 | 5.1 | 3.1 | 66 | 56.6 | 34.0 | 26 | 108.0 | 64.9 | 86 | 159.4 | 95.8 | 46 | 210.9 | 126.7 |
| 7 | 6.0 | 3.6 | 67 | 57.4 | 34.5 | 27 | 108.9 | 65.4 | 87 | 160.3 | 96.3 | 47 | 211.7 | 127.2 |
| 8 | 6.9 | 4.1 | 68 | 58.3 | 35.0 | 28 | 109.7 | 65.9 | 88 | 161.1 | 96.8 | 48 | 212.6 | 127.7 |
| 9 | 7.7 | 4.6 | 69 | 59.1 | 35.5 | 29 | 110.6 | 66.4 | 89 | 162.0 | 97.3 | 49 | 213.4 | 128.2 |
| 10 | 8.6 | 5.2 | 70 | 60.0 | 36.1 | 30 | 111.4 | 67.0 | 90 | 162.9 | 97.9 | 50 | 214.3 | 128.8 |
| 11 | 9.4 | 5.7 | 71 | 60.9 | 36.6 | 131 | 112.3 | 67.5 | 191 | 163.7 | 98.4 | 251 | 215.1 | 129.3 |
| 12 | 10.3 | 6.2 | 72 | 61.7 | 37.1 | 32 | 113.1 | 68.0 | 92 | 164.6 | 98.9 | 52 | 216.0 | 129.8 |
| 13 | 11.1 | 6.7 | 73 | 62.6 | 37.6 | 33 | 114.0 | 68.5 | 93 | 165.4 | 99.4 | 53 | 216.9 | 130.3 |
| 14 | 12.0 | 7.2 | 74 | 63.4 | 38.1 | 34 | 114.9 | 69.0 | 94 | 166.3 | 99.9 | 54 | 217.7 | 130.8 |
| 15 | 12.9 | 7.7 | 75 | 64.3 | 38.6 | 35 | 115.7 | 69.5 | 95 | 167.1 | 100.4 | 55 | 218.6 | 131.3 |
| 16 | 13.7 | 8.2 | 76 | 65.1 | 39.1 | 36 | 116.6 | 70.0 | 96 | 168.0 | 100.9 | 56 | 219.4 | 131.8 |
| 17 | 14.6 | 8.8 | 77 | 66.0 | 39.7 | 37 | 117.4 | 70.6 | 97 | 168.9 | 101.5 | 57 | 220.3 | 132.4 |
| 18 | 15.4 | 9.3 | 78 | 66.9 | 40.2 | 38 | 118.3 | 71.1 | 98 | 169.7 | 102.0 | 58 | 221.1 | 132.9 |
| 19 | 16.3 | 9.8 | 79 | 67.7 | 40.7 | 39 | 119.1 | 71.6 | 99 | 170.6 | 102.5 | 59 | 222.0 | 133.4 |
| 20 | 17.1 | 10.3 | 80 | 68.6 | 41.2 | 40 | 120.0 | 72.1 | 200 | 171.4 | 103.0 | 60 | 222.9 | 133.9 |
| 21 | 18.0 | 10.8 | 81 | 69.4 | 41.7 | 141 | 120.9 | 72.6 | 201 | 172.3 | 103.5 | 261 | 223.7 | 134.4 |
| 22 | 18.9 | 11.3 | 82 | 70.3 | 42.2 | 42 | 121.7 | 73.1 | 02 | 173.1 | 104.0 | 62 | 224.6 | 134.9 |
| 23 | 19.7 | 11.8 | 83 | 71.1 | 42.7 | 43 | 122.6 | 73.7 | 03 | 174.0 | 104.6 | 63 | 225.4 | 135.5 |
| 24 | 20.6 | 12.4 | 84 | 72.0 | 43.3 | 44 | 123.4 | 74.2 | 04 | 174.9 | 105.1 | 64 | 226.3 | 136.0 |
| 25 | 21.4 | 12.9 | 85 | 72.9 | 43.8 | 45 | 124.3 | 74.7 | 05 | 175.7 | 105.6 | 65 | 227.1 | 136.5 |
| 26 | 22.3 | 13.4 | 86 | 73.7 | 44.3 | 46 | 125.1 | 75.2 | 06 | 176.6 | 106.1 | 66 | 228.0 | 137.0 |
| 27 | 23.1 | 13.9 | 87 | 74.6 | 44.8 | 47 | 126.0 | 75.7 | 07 | 177.4 | 106.6 | 67 | 228.9 | 137.5 |
| 28 | 24.0 | 14.4 | 88 | 75.4 | 45.3 | 48 | 126.9 | 76.2 | 08 | 178.3 | 107.1 | 68 | 229.7 | 138.0 |
| 29 | 24.9 | 14.9 | 89 | 76.3 | 45.8 | 49 | 127.7 | 76.7 | 09 | 179.1 | 107.6 | 69 | 230.6 | 138.5 |
| 30 | 25.7 | 15.5 | 90 | 77.1 | 46.4 | 50 | 128.6 | 77.3 | 10 | 180.0 | 108.2 | 70 | 231.4 | 139.1 |
| 31 | 26.6 | 16.0 | 91 | 78.0 | 46.9 | 151 | 129.4 | 77.8 | 211 | 180.9 | 108.7 | 271 | 232.3 | 139.6 |
| 32 | 27.4 | 16.5 | 92 | 78.9 | 47.4 | 52 | 130.3 | 78.3 | 12 | 181.7 | 109.2 | 72 | 233.1 | 140.1 |
| 33 | 28.3 | 17.0 | 93 | 79.7 | 47.9 | 53 | 131.1 | 78.8 | 13 | 182.6 | 109.7 | 73 | 234 0 | 140.6 |
| 34 | 29.1 | 17.5 | 94 | 80.6 | 48.4 | 54 | 132.0 | 79.3 | 14 | 183.4 | 110.2 | 74 | 234.9 | 141.1 |
| 35 | 30.0 | 18.0 | 95 | 81.4 | 48.9 | 55 | 132.9 | 79.8 | 15 | 184.3 | 110.7 | 75 | 235.7 | 141.6 |
| 36 | 30.9 | 18.5 | 96 | 82.3 | 49.4 | 56 | 133.7 | 80.3 | 16 | 185.1 | 111.2 | 76 | 236.6 | 142.2 |
| 37 | 31.7 | 19.1 | 97 | 83.1 | 50.0 | 57 | 134.6 | 80.9 | 17 | 186.0 | 111.8 | 77 | 237.4 | 142.7 |
| 38 | 32.6 | 19.6 | 98 | 84.0 | 50.5 | 58 | 135.4 | 81.4 | 18 | 186.9 | 112.3 | 78 | 238.3 | 143.2 |
| 39 | 33.4 | 20.1 | 99 | 84.9 | 51.0 | 59 | 136.3 | 81.9 | 19 | 187.7 | 112.8 | 79 | 239.1 | 143.7 |
| 40 | 34.3 | 20.6 | 100 | 85.7 | 51.5 | 60 | 137.1 | 82.4 | 20 | 188.6 | 113.3 | 80 | 240.0 | 144.2 |
| 41 | 35.1 | 21.1 | 101 | 86.6 | 52.0 | 161 | 138.0 | 82.9 | 221 | 189.4 | 113.8 | 281 | 240.9 | 144.7 |
| 42 | 36.0 | 21.6 | 02 | 87.4 | 52.5 | 62 | 138.9 | 83.4 | 22 | 190.3 | 114.3 | 82 | 241.7 | 145.2 |
| 43 | 36.9 | 22.1 | 03 | 88.3 | 53.0 | 63 | 139.7 | 84.0 | 23 | 191.1 | 114.9 | 83 | 242.6 | 145.8 |
| 44 | 37.7 | 22.7 | 04 | 89.1 | 53.6 | 64 | 140.6 | 84.5 | 24 | 192.0 | 115.4 | 84 | 243.4 | 146.3 |
| 45 | 38.6 | 23.2 | 05 | 90.0 | 54.1 | 65 | 141.4 | 85.0 | 25 | 192.9 | 115.9 | 85 | 244.3 | 146.8 |
| 46 | 39.4 | 23.7 | 06 | 90.9 | 54.6 | 66 | 142.3 | 85.5 | 26 | 193.7 | 116.4 | 86 | 245.1 | 147.3 |
| 47 | 40.3 | 24.2 | 07 | 91.7 | 55.1 | 67 | 143.1 | 86.0 | 27 | 194.6 | 116.9 | 87 | 246.0 | 147.8 |
| 48 | 41.1 | 24.7 | 08 | 92.6 | 55.6 | 68 | 144.0 | 86.5 | 28 | 195.4 | 117.4 | 88 | 246.9 | 148.3 |
| 49 | 42.0 | 25.2 | 09 | 93.4 | 56.1 | 69 | 144.9 | 87.0 | 29 | 196.3 | 117.9 | 89 | 247.7 | 148.8 |
| 50 | 42.9 | 25.8 | 10 | 94.3 | 56.7 | 70 | 145.7 | 87.6 | 30 | 197.1 | 118.5 | 90 | 248.6 | 149.4 |
| 51 | 43.7 | 26.3 | 111 | 95.1 | 57.2 | 171 | 146.6 | 88.1 | 231 | 198.0 | 119.0 | 291 | 249.4 | 149.9 |
| 52 | 44.6 | 26.8 | 12 | 96.0 | 57.7 | 72 | 147.4 | 88.6 | 32 | 198.9 | 119.5 | 92 | 250.3 | 150.4 |
| 53 | 45.4 | 27.3 | 13 | 96.9 | 58.2 | 73 | 148.3 | 89.1 | 33 | 199.7 | 120.0 | 93 | 251.2 | 150.9 |
| 54 | 46.3 | 27.8 | 14 | 97.7 | 58.7 | 74 | 149.1 | 89.6 | 34 | 200.6 | 120.5 | 94 | 252.0 | 151.4 |
| 55 | 47.1 | 28.3 | 15 | 98.6 | 59.2 | 75 | 150.0 | 90.1 | 35 | 201.4 | 121.0 | 95 | 252.9 | 151.9 |
| 56 | 48.0 | 28.8 | 16 | 99 4 | 59.7 | 76 | 150.9 | 90.6 | 36 | 202.3 | 121.5 | 96 | 253.7 | 152.5 |
| 57 | 48.9 | 29.4 | 17 | 100.3 | 60.3 | 77 | 151.7 | 91.2 | 37 | 203.1 | 122.1 | 97 | 254.6 | 153.0 |
| 58 | 49.7 | 29.9 | 18 | 101.1 | 60.8 | 78 | 152.6 | 91.7 | 38 | 204.0 | 122.6 | 98 | 255.4 | 153.5 |
| 59 | 50.6 | 30.4 | 19 | 102.0 | 61.3 | 79 | 153.4 | 92.2 | 39 | 204.9 | 123.1 | 99 | 256.3 | 154.0 |
| 60 | 51.4 | 30.9 | 20 | 102.9 | 61.8 | 80 | 154.3 | 92.7 | 40 | 205.7 | 123.6 | 300 | 257.1 | 154.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

59° (121°, 239°, 301°).

TABLE 2. [Page 429

Difference of Latitude and Departure for 31° (149°, 211°, 329°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 258.0 | 155.0 | 361 | 309.4 | 185.9 | 421 | 360.9 | 216.8 | 481 | 412.3 | 247.7 | 541 | 463.7 | 278.6 |
| 02 | 258.9 | 155.5 | 62 | 310.3 | 186.4 | 22 | 361.7 | 217.3 | 82 | 413.2 | 248.2 | 42 | 464.6 | 279.1 |
| 03 | 259.7 | 156.1 | 63 | 311.2 | 187.0 | 23 | 362.6 | 217.9 | 83 | 414.0 | 248.8 | 43 | 465.4 | 279.7 |
| 04 | 260.6 | 156.6 | 64 | 312.0 | 187 5 | 24 | 363.4 | 218.4 | 84 | 414.9 | 249.3 | 44 | 466.3 | 280.2 |
| 05 | 261.4 | 157.1 | 65 | 312.9 | 188.0 | 25 | 364.3 | 218.9 | 85 | 415.7 | 249.8 | 45 | 467.2 | 280.7 |
| 06 | 262.3 | 157.6 | 66 | 313.7 | 188.5 | 26 | 365.2 | 219.4 | 86 | 416.6 | 250.3 | 46 | 468.0 | 281.2 |
| 07 | 263.2 | 158.1 | 67 | 314.6 | 189.0 | 27 | 366.0 | 219.9 | 87 | 417.4 | 250.8 | 47 | 468.9 | 281.7 |
| 08 | 264.0 | 158.6 | 68 | 315.4 | 189.5 | 28 | 366.9 | 220.4 | 88 | 418.3 | 251.3 | 48 | 469.7 | 282.3 |
| 09 | 264.9 | 159.2 | 69 | 316.3 | 190.1 | 29 | 367.7 | 221.0 | 89 | 419.2 | 251.9 | 49 | 470.6 | 282.8 |
| 10 | 265.7 | 159.7 | 70 | 317.2 | 190.6 | 30 | 368.6 | 221.5 | 90 | 420.0 | 252.4 | 50 | 471.4 | 283.3 |
| 311 | 266.6 | 160.2 | 371 | 318.0 | 191.1 | 431 | 369.4 | 222.0 | 491 | 420.9 | 252.9 | 551 | 472.3 | 283.8 |
| 12 | 267.4 | 160.7 | 72 | 318.9 | 191.6 | 32 | 370.3 | 222.5 | 92 | 421.7 | 253.4 | 52 | 473.2 | 284.3 |
| 13 | 268.3 | 161.2 | 73 | 319.7 | 192.1 | 33 | 371.2 | 223.0 | 93 | 422.6 | 253.9 | 53 | 474.0 | 284.8 |
| 14 | 269.2 | 161.7 | 74 | 320.6 | 192.6 | 34 | 372.0 | 223.5 | 94 | 423.4 | 254.4 | 54 | 474.9 | 285.3 |
| 15 | 270.0 | 162.2 | 75 | 321.4 | 193.1 | 35 | 372.9 | 224.0 | 95 | 424.3 | 254.9 | 55 | 475.7 | 285.8 |
| 16 | 270.9 | 162.8 | 76 | 322.3 | 193.7 | 36 | 373.7 | 224.6 | 96 | 425.2 | 255.5 | 56 | 476.6 | 286.4 |
| 17 | 271.7 | 163.3 | 77 | 323.2 | 194.2 | 37 | 374.6 | 225.1 | 97 | 426.0 | 256.0 | 57 | 477.4 | 286.9 |
| 18 | 272.6 | 163.8 | 78 | 324.0 | 194.7 | 38 | 375.4 | 225.6 | 98 | 426.9 | 256.5 | 58 | 478.3 | 287.4 |
| 19 | 273.4 | 164.3 | 79 | 324.9 | 195.2 | 39 | 376.3 | 226.1 | 99 | 427.7 | 257.0 | 59 | 479.2 | 287.9 |
| 20 | 274.3 | 164.8 | 80 | 325.7 | 195.7 | 40 | 377.2 | 226.6 | 500 | 428.6 | 257.5 | 60 | 480.0 | 288.4 |
| 321 | 275.2 | 165.3 | 381 | 326.6 | 196.2 | 441 | 378.0 | 227.1 | 501 | 429.4 | 258.0 | 561 | 480.9 | 288.9 |
| 22 | 276.0 | 165.8 | 82 | 327.4 | 196.7 | 42 | 378.9 | 227.7 | 02 | 430.3 | 258.6 | 62 | 481.7 | 289.5 |
| 23 | 276.9 | 166.4 | 83 | 328.3 | 197.3 | 43 | 379.7 | 228.2 | 03 | 431.2 | 259.1 | 63 | 482.6 | 290.0 |
| 24 | 277.7 | 166.9 | 84 | 329.2 | 197.8 | 44 | 380.6 | 228.7 | 04 | 432.0 | 259.6 | 64 | 483.4 | 290.5 |
| 25 | 278.6 | 167.4 | 85 | 330.0 | 198.3 | 45 | 381.4 | 229.2 | 05 | 432.9 | 260.1 | 65 | 484.3 | 291.0 |
| 26 | 279.4 | 167.9 | 86 | 330.9 | 198.8 | 46 | 382.3 | 229.7 | 06 | 433.7 | 260.6 | 66 | 485.2 | 291.5 |
| 27 | 280.3 | 168.4 | 87 | 331.7 | 199.3 | 47 | 383.2 | 230.2 | 07 | 434.6 | 261.1 | 67 | 486.0 | 292.0 |
| 28 | 281.2 | 168.9 | 88 | 332.6 | 199.8 | 48 | 384.0 | 230.7 | 08 | 435.4 | 261.6 | 68 | 486.9 | 292.5 |
| 29 | 282.0 | 169.5 | 89 | 333.4 | 200.4 | 49 | 384.9 | 231.3 | 09 | 436.3 | 262.2 | 69 | 487.7 | 293.1 |
| 30 | 282 9 | 170.0 | 90 | 334.3 | 200.9 | 50 | 385.7 | 231.8 | 10 | 437.2 | 262.7 | 70 | 488.6 | 293.6 |
| 331 | 283.7 | 170.5 | 391 | 335.2 | 201.4 | 451 | 386.6 | 232.3 | 511 | 438.0 | 263.2 | 571 | 489.4 | 294.1 |
| 32 | 284.6 | 171.0 | 92 | 336.0 | 201.9 | 52 | 387.4 | 232.8 | 12 | 438.9 | 263.7 | 72 | 490.3 | 294.6 |
| 33 | 285.4 | 171.5 | 93 | 336.9 | 202.4 | 53 | 388.3 | 233.3 | 13 | 439.7 | 264.2 | 73 | 491.2 | 295.1 |
| 34 | 286.3 | 172.0 | 94 | 337.7 | 202.9 | 54 | 389.2 | 233.8 | 14 | 440.6 | 264.7 | 74 | 492.0 | 295.6 |
| 35 | 287.2 | 172.5 | 95 | 338.6 | 203.4 | 55 | 390.0 | 234.3 | 15 | 441.4 | 265.2 | 75 | 492.9 | 296.1 |
| 36 | 288.0 | 173.1 | 96 | 339.4 | 204.0 | 56 | 390.9 | 234.9 | 16 | 442.3 | 265.8 | 76 | 493.7 | 296.7 |
| 37 | 288.9 | 173.6 | 97 | 340.3 | 204.5 | 57 | 391.7 | 235.4 | 17 | 443.2 | 266.3 | 77 | 494.6 | 297.2 |
| 38 | 289.7 | 174.1 | 98 | 341.2 | 205.0 | 58 | 392.6 | 235.9 | 18 | 444.0 | 266.8 | 78 | 495.4 | 297.7 |
| 39 | 290.6 | 174.6 | 99 | 342.0 | 205.5 | 59 | 393.4 | 236.4 | 19 | 444.9 | 267.3 | 79 | 496.3 | 298.2 |
| 40 | 291.4 | 175.1 | 400 | 342.9 | 206.0 | 60 | 394.3 | 236.9 | 20 | 445.7 | 267.8 | 80 | 497.2 | 298.7 |
| 341 | 292.3 | 175.6 | 401 | 343.7 | 206.5 | 461 | 395.2 | 237.4 | 521 | 446.6 | 268.3 | 581 | 498.0 | 299.2 |
| 42 | 293.2 | 176.1 | 02 | 344.6 | 207.0 | 62 | 396.0 | 238.0 | 22 | 447.4 | 268.9 | 82 | 498.9 | 299.8 |
| 43 | 294.0 | 176.7 | 03 | 345.4 | 207.6 | 63 | 396.9 | 238.5 | 23 | 448.3 | 269.4 | 83 | 499.7 | 300.3 |
| 44 | 294.9 | 177.2 | 04 | 346.3 | 208.1 | 64 | 397.7 | 239.0 | 24 | 449.2 | 269.9 | 84 | 500.6 | 300.8 |
| 45 | 295.7 | 177.7 | 05 | 347.2 | 208.6 | 65 | 398.6 | 239.5 | 25 | 450.0 | 270.4 | 85 | 501.4 | 301.3 |
| 46 | 296.6 | 178.2 | 06 | 348.0 | 209.1 | 66 | 399.4 | 240.0 | 26 | 450.9 | 270.9 | 86 | 502.3 | 301.8 |
| 47 | 297.4 | 178.7 | 07 | 348.9 | 209.6 | 67 | 400.3 | 240.5 | 27 | 451.7 | 271.4 | 87 | 503.2 | 302.3 |
| 48 | 298.3 | 179.2 | 08 | 349.7 | 210.1 | 68 | 401.2 | 241.0 | 28 | 452.6 | 271.9 | 88 | 504.0 | 302.8 |
| 49 | 299.2 | 179.8 | 09 | 350.6 | 210.7 | 69 | 402.0 | 241.5 | 29 | 453.4 | 272.4 | 89 | 504.9 | 303.3 |
| 50 | 300.0 | 180.3 | 10 | 351.4 | 211.2 | 70 | 402.9 | 242.1 | 30 | 454.3 | 273.0 | 90 | 505.7 | 303.9 |
| 351 | 300.9 | 180.8 | 411 | 352.3 | 211.7 | 471 | 403.7 | 242.6 | 531 | 455.2 | 273.5 | 591 | 506.6 | 304.4 |
| 52 | 301.7 | 181.3 | 12 | 353.2 | 212.2 | 72 | 404.6 | 243.1 | 32 | 456.0 | 274.0 | 92 | 507.4 | 304.9 |
| 53 | 302.6 | 181.8 | 13 | 354.0 | 212.7 | 73 | 405.4 | 243.6 | 33 | 456.9 | 274.5 | 93 | 508.3 | 305.4 |
| 54 | 303.4 | 182.3 | 14 | 354.9 | 213.2 | 74 | 406.3 | 244.1 | 34 | 457.7 | 275.0 | 94 | 509.2 | 305.9 |
| 55 | 304.3 | 182.8 | 15 | 355.7 | 213.7 | 75 | 407.2 | 244.6 | 35 | 458.6 | 275.5 | 95 | 510.0 | 306.4 |
| 56 | 305.2 | 183.4 | 16 | 356.6 | 214.3 | 76 | 408.0 | 245.2 | 36 | 459.4 | 276.1 | 96 | 510.9 | 307.0 |
| 57 | 306.0 | 183.9 | 17 | 357.4 | 214.8 | 77 | 408.9 | 245.7 | 37 | 460.3 | 276.6 | 97 | 511.7 | 307.5 |
| 58 | 306.9 | 184.4 | 18 | 358.3 | 215.3 | 78 | 409.7 | 246.2 | 38 | 461.2 | 277.1 | 98 | 512.6 | 308.0 |
| 59 | 307.7 | 184.9 | 19 | 359.2 | 215.8 | 79 | 410.6 | 246.7 | 39 | 462.0 | 277.6 | 99 | 513.4 | 308.5 |
| 60 | 308.6 | 185.4 | 20 | 360.0 | 216.3 | 80 | 411.4 | 247.2 | 40 | 462.9 | 278.1 | 600 | 514.3 | 309.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

59° (121°, 239°, 301°).

## TABLE 2.

### Difference of Latitude and Departure for 32° (148°, 212°, 328°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.5 | 61 | 51.7 | 32.3 | 121 | 102.6 | 64.1 | 181 | 153.5 | 95.9 | 241 | 204.4 | 127.7 |
| 2 | 1.7 | 1.1 | 62 | 52.6 | 32.9 | 22 | 103.5 | 64.7 | 82 | 154.3 | 96.4 | 42 | 205.2 | 128.2 |
| 3 | 2.5 | 1.6 | 63 | 53.4 | 33.4 | 23 | 104.3 | 65.2 | 83 | 155.2 | 97.0 | 43 | 206.1 | 128.8 |
| 4 | 3.4 | 2.1 | 64 | 54.3 | 33.9 | 24 | 105.2 | 65.7 | 84 | 156.0 | 97.5 | 44 | 206.9 | 129.3 |
| 5 | 4.2 | 2.6 | 65 | 55.1 | 34.4 | 25 | 106.0 | 66.2 | 85 | 156.9 | 98.0 | 45 | 207.8 | 129.8 |
| 6 | 5.1 | 3.2 | 66 | 56.0 | 35.0 | 26 | 106.9 | 66.8 | 86 | 157.7 | 98.6 | 46 | 208.6 | 130.4 |
| 7 | 5.9 | 3.7 | 67 | 56.8 | 35.5 | 27 | 107.7 | 67.3 | 87 | 158.6 | 99.1 | 47 | 209.5 | 130.9 |
| 8 | 6.8 | 4.2 | 68 | 57.7 | 36.0 | 28 | 108.6 | 67.8 | 88 | 159.4 | 99.6 | 48 | 210.3 | 131.4 |
| 9 | 7.6 | 4.8 | 69 | 58.5 | 36.6 | 29 | 109.4 | 68.4 | 89 | 160.3 | 100.2 | 49 | 211.2 | 131.9 |
| 10 | 8.5 | 5.3 | 70 | 59.4 | 37.1 | 30 | 110.2 | 68.9 | 90 | 161.1 | 100.7 | 50 | 212.0 | 132.5 |
| 11 | 9.3 | 5.8 | 71 | 60.2 | 37.6 | 131 | 111.1 | 69.4 | 191 | 162.0 | 101.2 | 251 | 212.9 | 133.0 |
| 12 | 10.2 | 6.4 | 72 | 61.1 | 38.2 | 32 | 111.9 | 69.9 | 92 | 162.8 | 101.7 | 52 | 213.7 | 133.5 |
| 13 | 11.0 | 6.9 | 73 | 61.9 | 38.7 | 33 | 112.8 | 70.5 | 93 | 163.7 | 102.3 | 53 | 214.6 | 134.1 |
| 14 | 11.9 | 7.4 | 74 | 62.8 | 39.2 | 34 | 113.6 | 71.0 | 94 | 164.5 | 102.8 | 54 | 215.4 | 134.6 |
| 15 | 12.7 | 7.9 | 75 | 63.6 | 39.7 | 35 | 114.5 | 71.5 | 95 | 165.4 | 103.3 | 55 | 216.3 | 135.1 |
| 16 | 13.6 | 8.5 | 76 | 64.5 | 40.3 | 36 | 115.3 | 72.1 | 96 | 166.2 | 103.9 | 56 | 217.1 | 135.7 |
| 17 | 14.4 | 9.0 | 77 | 65.3 | 40.8 | 37 | 116.2 | 72.6 | 97 | 167.1 | 104.4 | 57 | 217.9 | 136.2 |
| 18 | 15.3 | 9.5 | 78 | 66.1 | 41.3 | 38 | 117.0 | 73.1 | 98 | 167.9 | 104.9 | 58 | 218.8 | 136.7 |
| 19 | 16.1 | 10.1 | 79 | 67.0 | 41.9 | 39 | 117.9 | 73.7 | 99 | 168.8 | 105.5 | 59 | 219.6 | 137.2 |
| 20 | 17.0 | 10.6 | 80 | 67.8 | 42.4 | 40 | 118.7 | 74.2 | 200 | 169.6 | 106.0 | 60 | 220.5 | 137.8 |
| 21 | 17.8 | 11.1 | 81 | 68.7 | 42.9 | 141 | 119.6 | 74.7 | 201 | 170.5 | 106.5 | 261 | 221.3 | 138.3 |
| 22 | 18.7 | 11.7 | 82 | 69.5 | 43.5 | 42 | 120.4 | 75.2 | 02 | 171.3 | 107.0 | 62 | 222.2 | 138.8 |
| 23 | 19.5 | 12.2 | 83 | 70.4 | 44.0 | 43 | 121.3 | 75.8 | 03 | 172.2 | 107.6 | 63 | 223.0 | 139.4 |
| 24 | 20.4 | 12.7 | 84 | 71.2 | 44.5 | 44 | 122.1 | 76.3 | 04 | 173.0 | 108.1 | 64 | 223.9 | 139.9 |
| 25 | 21.2 | 13.2 | 85 | 72.1 | 45.0 | 45 | 123.0 | 76.8 | 05 | 173.8 | 108.6 | 65 | 224.7 | 140.4 |
| 26 | 22.0 | 13.8 | 86 | 72.9 | 45.6 | 46 | 123.8 | 77.4 | 06 | 174.7 | 109.2 | 66 | 225.6 | 141.0 |
| 27 | 22.9 | 14.3 | 87 | 73.8 | 46.1 | 47 | 124.7 | 77.9 | 07 | 175.5 | 109.7 | 67 | 226.4 | 141.5 |
| 28 | 23.7 | 14.8 | 88 | 74.6 | 46.6 | 48 | 125.5 | 78.4 | 08 | 176.4 | 110.2 | 68 | 227.3 | 142.0 |
| 29 | 24.6 | 15.4 | 89 | 75.5 | 47.2 | 49 | 126.4 | 79.0 | 09 | 177.2 | 110.8 | 69 | 228.1 | 142.5 |
| 30 | 25.4 | 15.9 | 90 | 76.3 | 47.7 | 50 | 127.2 | 79.5 | 10 | 178.1 | 111.3 | 70 | 229.0 | 143.1 |
| 31 | 26.3 | 16.4 | 91 | 77.2 | 48.2 | 151 | 128.1 | 80.0 | 211 | 178.9 | 111.8 | 271 | 229.8 | 143.6 |
| 32 | 27.1 | 17.0 | 92 | 78.0 | 48.8 | 52 | 128.9 | 80.5 | 12 | 179.8 | 112.3 | 72 | 230.7 | 144.1 |
| 33 | 28.0 | 17.5 | 93 | 78.9 | 49.3 | 53 | 129.8 | 81.1 | 13 | 180.6 | 112.9 | 73 | 231.5 | 144.7 |
| 34 | 28.8 | 18.0 | 94 | 79.7 | 49.8 | 54 | 130.6 | 81.6 | 14 | 181.5 | 113.4 | 74 | 232.4 | 145.2 |
| 35 | 29.7 | 18.5 | 95 | 80.6 | 50.3 | 55 | 131.4 | 82.1 | 15 | 182.3 | 113.9 | 75 | 233.2 | 145.7 |
| 36 | 30.5 | 19.1 | 96 | 81.4 | 50.9 | 56 | 132.3 | 82.7 | 16 | 183.2 | 114.5 | 76 | 234.1 | 146.3 |
| 37 | 31.4 | 19.6 | 97 | 82.3 | 51.4 | 57 | 133.1 | 83.2 | 17 | 184.0 | 115.0 | 77 | 234.9 | 146.8 |
| 38 | 32.2 | 20.1 | 98 | 83.1 | 51.9 | 58 | 134.0 | 83.7 | 18 | 184.9 | 115.5 | 78 | 235.8 | 147.3 |
| 39 | 33.1 | 20.7 | 99 | 84.0 | 52.5 | 59 | 134.8 | 84.3 | 19 | 185.7 | 116.1 | 79 | 236.6 | 147.8 |
| 40 | 33.9 | 21.2 | 100 | 84.8 | 53.0 | 60 | 135.7 | 84.8 | 20 | 186.6 | 116.6 | 80 | 237.5 | 148.4 |
| 41 | 34.8 | 21.7 | 101 | 85.7 | 53.5 | 161 | 136.5 | 85.3 | 221 | 187.4 | 117.1 | 281 | 238.3 | 148.9 |
| 42 | 35.6 | 22.3 | 02 | 86.5 | 54.1 | 62 | 137.4 | 85.8 | 22 | 188.3 | 117.6 | 82 | 239.1 | 149.4 |
| 43 | 36.5 | 22.8 | 03 | 87.3 | 54.6 | 63 | 138.2 | 86.4 | 23 | 189.1 | 118.2 | 83 | 240.0 | 150.0 |
| 44 | 37.3 | 23.3 | 04 | 88.2 | 55.1 | 64 | 139.1 | 86.9 | 24 | 190.0 | 118.7 | 84 | 240.8 | 150.5 |
| 45 | 38.2 | 23.8 | 05 | 89.0 | 55.6 | 65 | 139.9 | 87.4 | 25 | 190.8 | 119.2 | 85 | 241.7 | 151.0 |
| 46 | 39.0 | 24.4 | 06 | 89.9 | 56.2 | 66 | 140.8 | 88.0 | 26 | 191.7 | 119.8 | 86 | 242.5 | 151.6 |
| 47 | 39.9 | 24.9 | 07 | 90.7 | 56.7 | 67 | 141.6 | 88.5 | 27 | 192.5 | 120.3 | 87 | 243.4 | 152.1 |
| 48 | 40.7 | 25.4 | 08 | 91.6 | 57.2 | 68 | 142.5 | 89.0 | 28 | 193.4 | 120.8 | 88 | 244.2 | 152.6 |
| 49 | 41.6 | 26.0 | 09 | 92.4 | 57.8 | 69 | 143.3 | 89.6 | 29 | 194.2 | 121.4 | 89 | 245.1 | 153.1 |
| 50 | 42.4 | 26.5 | 10 | 93.3 | 58.3 | 70 | 144.2 | 90.1 | 30 | 195.1 | 121.9 | 90 | 245.9 | 153.7 |
| 51 | 43.3 | 27.0 | 111 | 94.1 | 58.8 | 171 | 145.0 | 90.6 | 231 | 195.9 | 122.4 | 291 | 246.8 | 154.2 |
| 52 | 44.1 | 27.6 | 12 | 95.0 | 59.4 | 72 | 145.9 | 91.1 | 32 | 196.7 | 122.9 | 92 | 247.6 | 154.7 |
| 53 | 44.9 | 28.1 | 13 | 95.8 | 59.9 | 73 | 146.7 | 91.7 | 33 | 197.6 | 123.5 | 93 | 248.5 | 155.3 |
| 54 | 45.8 | 28.6 | 14 | 96.7 | 60.4 | 74 | 147.6 | 92.2 | 34 | 198.4 | 124.0 | 94 | 249.3 | 155.8 |
| 55 | 46.6 | 29.1 | 15 | 97.5 | 60.9 | 75 | 148.4 | 92.7 | 35 | 199.3 | 124.5 | 95 | 250.2 | 156.3 |
| 56 | 47.5 | 29.7 | 16 | 98.4 | 61.5 | 76 | 149.3 | 93.3 | 36 | 200.1 | 125.1 | 96 | 251.0 | 156.9 |
| 57 | 48.3 | 30.2 | 17 | 99.2 | 62.0 | 77 | 150.1 | 93.8 | 37 | 201.0 | 125.6 | 97 | 251.9 | 157.4 |
| 58 | 49.2 | 30.7 | 18 | 100.1 | 62.5 | 78 | 151.0 | 94.3 | 38 | 201.8 | 126.1 | 98 | 252.7 | 157.9 |
| 59 | 50.0 | 31.3 | 19 | 100.9 | 63.1 | 79 | 151.8 | 94.9 | 39 | 202.7 | 126.7 | 99 | 253.6 | 158.4 |
| 60 | 50.9 | 31.8 | 20 | 101.8 | 63.6 | 80 | 152.6 | 95.4 | 40 | 203.5 | 127.2 | 300 | 254.4 | 159.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 58° (122°, 238°, 302°).

TABLE 2. [Page 431

Difference of Latitude and Departure for 32° (148°, 212°, 328°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 255.3 | 159.5 | 361 | 306.2 | 191.3 | 421 | 357.0 | 223.1 | 481 | 407.9 | 254.9 | 541 | 458.8 | 286.7 |
| 02 | 256.1 | 160.0 | 62 | 307.0 | 191.8 | 22 | 357.9 | 223.6 | 82 | 408.8 | 255.4 | 42 | 459.6 | 287.2 |
| 03 | 257.0 | 160.5 | 63 | 307.9 | 192.3 | 23 | 358.7 | 224.1 | 83 | 409.6 | 255.9 | 43 | 460.5 | 287.7 |
| 04 | 257.8 | 161.1 | 64 | 308.7 | 192.9 | 24 | 359.6 | 224.7 | 84 | 410.5 | 256.5 | 44 | 461.3 | 288.3 |
| 05 | 258.7 | 161.6 | 65 | 309.5 | 193.4 | 25 | 360.4 | 225.2 | 85 | 411.3 | 257.0 | 45 | 462.2 | 288.8 |
| 06 | 259.5 | 162.1 | 66 | 310.4 | 193.9 | 26 | 361.3 | 225.7 | 86 | 412.2 | 257.5 | 46 | 463.0 | 289.3 |
| 07 | 260.4 | 162.7 | 67 | 311.2 | 194.5 | 27 | 362.1 | 226.3 | 87 | 413.0 | 258.1 | 47 | 463.9 | 289.9 |
| 08 | 261.2 | 163.2 | 68 | 312.1 | 195.0 | 28 | 363.0 | 226.8 | 88 | 413.9 | 258.6 | 48 | 464.7 | 290.4 |
| 09 | 262.1 | 163.7 | 69 | 312.9 | 195.5 | 29 | 363.8 | 227.3 | 89 | 414.7 | 259.1 | 49 | 465.6 | 290.9 |
| 10 | 262.9 | 164.3 | 70 | 313.8 | 196.0 | 30 | 364.7 | 227.8 | 90 | 415.6 | 259.6 | 50 | 466.4 | 291.5 |
| 311 | 263.8 | 164.8 | 371 | 314.6 | 196.6 | 431 | 365.5 | 228.4 | 491 | 416.4 | 260.2 | 551 | 467.3 | 292.0 |
| 12 | 264.6 | 165.3 | 72 | 315.5 | 197.1 | 32 | 366.4 | 228.9 | 92 | 417.3 | 260.7 | 52 | 468.1 | 292.5 |
| 13 | 265.4 | 165.8 | 73 | 316.3 | 197.6 | 33 | 367.2 | 229.4 | 93 | 418.1 | 261.2 | 53 | 469.0 | 293.0 |
| 14 | 266.3 | 166.4 | 74 | 317.2 | 198.2 | 34 | 368.1 | 230.0 | 94 | 419.0 | 261.8 | 54 | 469.8 | 293.6 |
| 15 | 267.1 | 166.9 | 75 | 318.0 | 198.7 | 35 | 368.9 | 230.5 | 95 | 419.8 | 262.3 | 55 | 470.7 | 294.1 |
| 16 | 268.0 | 167.4 | 76 | 318.9 | 199.2 | 36 | 369.8 | 231.0 | 96 | 420.6 | 262.8 | 56 | 471.5 | 294.6 |
| 17 | 268.8 | 168.0 | 77 | 319.7 | 199.8 | 37 | 370.6 | 231.6 | 97 | 421.5 | 263.4 | 57 | 472.4 | 295.2 |
| 18 | 269.7 | 168.5 | 78 | 320.6 | 200.3 | 38 | 371.5 | 232.1 | 98 | 422.3 | 263.9 | 58 | 473.2 | 295.7 |
| 19 | 270.5 | 169.0 | 79 | 321.4 | 200.8 | 39 | 372.3 | 232.6 | 99 | 423.2 | 264.4 | 59 | 474.1 | 296.2 |
| 20 | 271.4 | 169.6 | 80 | 322.3 | 201.3 | 40 | 373.2 | 233.1 | 500 | 424.0 | 265.0 | 60 | 474.9 | 296.7 |
| 321 | 272.2 | 170.1 | 381 | 323.1 | 201.9 | 441 | 374.0 | 233.7 | 501 | 424.9 | 265.5 | 561 | 475.8 | 297.3 |
| 22 | 273.1 | 170.6 | 82 | 324.0 | 202.4 | 42 | 374.8 | 234.2 | 02 | 425.7 | 266.0 | 62 | 476.6 | 297.8 |
| 23 | 273.9 | 171.1 | 83 | 324.8 | 202.9 | 43 | 375.7 | 234.7 | 03 | 426.6 | 266.5 | 63 | 477.5 | 298.3 |
| 24 | 274.8 | 171.7 | 84 | 325.7 | 203.5 | 44 | 376.5 | 235.3 | 04 | 427.4 | 267.1 | 64 | 478.3 | 298.9 |
| 25 | 275.6 | 172.2 | 85 | 326.5 | 204.0 | 45 | 377.4 | 235.8 | 05 | 428.3 | 267.6 | 65 | 479.2 | 299.4 |
| 26 | 276.5 | 172.7 | 86 | 327.4 | 204.5 | 46 | 378.2 | 236.3 | 06 | 429.1 | 268.1 | 66 | 480.0 | 299.9 |
| 27 | 277.3 | 173.3 | 87 | 328.2 | 205.1 | 47 | 379.1 | 236.9 | 07 | 430.0 | 268.7 | 67 | 480.9 | 300.5 |
| 28 | 278.2 | 173.8 | 88 | 329.1 | 205.6 | 48 | 379.9 | 237.4 | 08 | 430.8 | 269.2 | 68 | 481.7 | 301.0 |
| 29 | 279.0 | 174.3 | 89 | 329.9 | 206.1 | 49 | 380.8 | 237.9 | 09 | 431.7 | 269.7 | 69 | 482.6 | 301.5 |
| 30 | 279.9 | 174.9 | 90 | 330.8 | 206.6 | 50 | 381.6 | 238.4 | 10 | 432.5 | 270.3 | 70 | 483.4 | 302.1 |
| 331 | 280.7 | 175.4 | 391 | 331.6 | 207.2 | 451 | 382.5 | 239.0 | 511 | 433.4 | 270.8 | 571 | 484.3 | 302.6 |
| 32 | 281.6 | 175.9 | 92 | 332.5 | 207.7 | 52 | 383.3 | 239.5 | 12 | 434.2 | 271.4 | 72 | 485.1 | 303.2 |
| 33 | 282.4 | 176.4 | 93 | 333.3 | 208.2 | 53 | 384.2 | 240.0 | 13 | 435.1 | 271.9 | 73 | 486.0 | 303.7 |
| 34 | 283.3 | 177.0 | 94 | 334.2 | 208.8 | 54 | 385.0 | 240.6 | 14 | 435.9 | 272.4 | 74 | 486.8 | 304.2 |
| 35 | 284.1 | 177.5 | 95 | 335.0 | 209.3 | 55 | 385.9 | 241.1 | 15 | 436.8 | 272.9 | 75 | 487.7 | 304.7 |
| 36 | 285.0 | 178.0 | 96 | 335.8 | 209.8 | 56 | 386.7 | 241.6 | 16 | 437.6 | 273.5 | 76 | 488.5 | 305.3 |
| 37 | 285.8 | 178.6 | 97 | 336.7 | 210.4 | 57 | 387.6 | 242.2 | 17 | 438.5 | 274.0 | 77 | 489.4 | 305.8 |
| 38 | 286.7 | 179.1 | 98 | 337.5 | 210.9 | 58 | 388.4 | 242.7 | 18 | 439.3 | 274.5 | 78 | 490.2 | 306.3 |
| 39 | 287.5 | 179.6 | 99 | 338.4 | 211.4 | 59 | 389.3 | 243.2 | 19 | 440.2 | 275.0 | 79 | 491.1 | 306.8 |
| 40 | 288.3 | 180.2 | 400 | 339.2 | 211.9 | 60 | 390.1 | 243.8 | 20 | 441.0 | 275.6 | 80 | 491.9 | 307.4 |
| 341 | 289.2 | 180.7 | 401 | 340.1 | 212.5 | 461 | 391.0 | 244.3 | 521 | 441.9 | 276.1 | 581 | 492.8 | 307.9 |
| 42 | 290.0 | 181.2 | 02 | 340.9 | 213.0 | 62 | 391.8 | 244.8 | 22 | 442.7 | 276.6 | 82 | 493.6 | 308.4 |
| 43 | 290.9 | 181.7 | 03 | 341.8 | 213.5 | 63 | 392.7 | 245.4 | 23 | 443.6 | 277.2 | 83 | 494.5 | 309.0 |
| 44 | 291.7 | 182.3 | 04 | 342.6 | 214.1 | 64 | 393.5 | 245.9 | 24 | 444.4 | 277.7 | 84 | 495.3 | 309.5 |
| 45 | 292.6 | 182.8 | 05 | 343.5 | 214.6 | 65 | 394.4 | 246.4 | 25 | 445.3 | 278.2 | 85 | 496.2 | 310.0 |
| 46 | 293.4 | 183.3 | 06 | 344.3 | 215.1 | 66 | 395.2 | 246.9 | 26 | 446.1 | 278.7 | 86 | 497.0 | 310.5 |
| 47 | 294.3 | 183.9 | 07 | 345.2 | 215.7 | 67 | 396.0 | 247.5 | 27 | 446.9 | 279.3 | 87 | 497.8 | 311.1 |
| 48 | 295.1 | 184.4 | 08 | 346.0 | 216.2 | 68 | 396.9 | 248.0 | 28 | 447.8 | 279.8 | 88 | 498.7 | 311.6 |
| 49 | 296.0 | 184.9 | 09 | 346.9 | 216.7 | 69 | 397.7 | 248.5 | 29 | 448.6 | 280.3 | 89 | 499.5 | 312.1 |
| 50 | 296.8 | 185.4 | 10 | 347.7 | 217.2 | 70 | 398.6 | 249.0 | 30 | 449.5 | 280.9 | 90 | 500.3 | 312.6 |
| 351 | 297.7 | 186.0 | 411 | 348.6 | 217.8 | 471 | 399.4 | 249.6 | 531 | 450.3 | 281.4 | 591 | 501.2 | 313.2 |
| 52 | 298.5 | 186.5 | 12 | 349.4 | 218.3 | 72 | 400.3 | 250.1 | 32 | 451.1 | 281.9 | 92 | 502.0 | 313.7 |
| 53 | 299.4 | 187.0 | 13 | 350.3 | 218.8 | 73 | 401.1 | 250.6 | 33 | 452.0 | 282.4 | 93 | 502.9 | 314.2 |
| 54 | 300.2 | 187.6 | 14 | 351.1 | 219.4 | 74 | 402.0 | 251.2 | 34 | 452.8 | 283.0 | 94 | 503.7 | 314.8 |
| 55 | 301.1 | 188.1 | 15 | 352.0 | 219.9 | 75 | 402.8 | 251.7 | 35 | 453.7 | 283.5 | 95 | 504.6 | 315.3 |
| 56 | 301.9 | 188.6 | 16 | 352.8 | 220.4 | 76 | 403.7 | 252.2 | 36 | 454.5 | 284.0 | 96 | 505.4 | 315.8 |
| 57 | 302.8 | 189.2 | 17 | 353.6 | 221.0 | 77 | 404.5 | 252.8 | 37 | 455.4 | 284.6 | 97 | 506.2 | 316.4 |
| 58 | 303.6 | 189.7 | 18 | 354.5 | 221.5 | 78 | 405.4 | 253.3 | 38 | 456.2 | 285.1 | 98 | 507.1 | 316.9 |
| 59 | 304.5 | 190.2 | 19 | 355.3 | 222.0 | 79 | 406.2 | 253.8 | 39 | 457.1 | 285.6 | 99 | 508.0 | 317.4 |
| 60 | 305.3 | 190.8 | 20 | 356.2 | 222.5 | 80 | 407.1 | 254.3 | 40 | 457.9 | 286.2 | 600 | 508.8 | 318.0 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

58° (122°, 238°, 302°).

# TABLE 2.

### Difference of Latitude and Departure for 33° (147°, 213°, 327°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.5 | 61 | 51.2 | 33.2 | 121 | 101.5 | 65.9 | 181 | 151.8 | 98.6 | 241 | 202.1 | 131.3 |
| 2 | 1.7 | 1.1 | 62 | 52.0 | 33.8 | 22 | 102.3 | 66.4 | 82 | 152.6 | 99.1 | 42 | 203.0 | 131.8 |
| 3 | 2.5 | 1.6 | 63 | 52.8 | 34.3 | 23 | 103.2 | 67.0 | 83 | 153.5 | 99.7 | 43 | 203.8 | 132.3 |
| 4 | 3.4 | 2.2 | 64 | 53.7 | 34.9 | 24 | 104.0 | 67.5 | 84 | 154.3 | 100.2 | 44 | 204.6 | 132.9 |
| 5 | 4.2 | 2.7 | 65 | 54.5 | 35.4 | 25 | 104.8 | 68.1 | 85 | 155.2 | 100.8 | 45 | 205.5 | 133.4 |
| 6 | 5.0 | 3.3 | 66 | 55.4 | 35.9 | 26 | 105.7 | 68.6 | 86 | 156.0 | 101.3 | 46 | 206.3 | 134.0 |
| 7 | 5.9 | 3.8 | 67 | 56.2 | 36.5 | 27 | 106.5 | 69.2 | 87 | 156.8 | 101.8 | 47 | 207.2 | 134.5 |
| 8 | 6.7 | 4.4 | 68 | 57.0 | 37.0 | 28 | 107.3 | 69.7 | 88 | 157.7 | 102.4 | 48 | 208.0 | 135.1 |
| 9 | 7.5 | 4.9 | 69 | 57.9 | 37.6 | 29 | 108.2 | 70.3 | 89 | 158.5 | 102.9 | 49 | 208.8 | 135.6 |
| 10 | 8.4 | 5.4 | 70 | 58.7 | 38.1 | 30 | 109.0 | 70.8 | 90 | 159.3 | 103.5 | 50 | 209.7 | 136.2 |
| 11 | 9.2 | 6.0 | 71 | 59.5 | 38.7 | 131 | 109.9 | 71.3 | 191 | 160.2 | 104.0 | 251 | 210.5 | 136.7 |
| 12 | 10.1 | 6.5 | 72 | 60.4 | 39.2 | 32 | 110.7 | 71.9 | 92 | 161.0 | 104.6 | 52 | 211.3 | 137.2 |
| 13 | 10.9 | 7.1 | 73 | 61.2 | 39.8 | 33 | 111.5 | 72.4 | 93 | 161.9 | 105.1 | 53 | 212.2 | 137.8 |
| 14 | 11.7 | 7.6 | 74 | 62.1 | 40.3 | 34 | 112.4 | 73.0 | 94 | 162.7 | 105.7 | 54 | 213.0 | 138.3 |
| 15 | 12.6 | 8.2 | 75 | 62.9 | 40.8 | 35 | 113.2 | 73.5 | 95 | 163.5 | 106.2 | 55 | 213.9 | 138.9 |
| 16 | 13.4 | 8.7 | 76 | 63.7 | 41.4 | 36 | 114.1 | 74.1 | 96 | 164.4 | 106.7 | 56 | 214.7 | 139.4 |
| 17 | 14.3 | 9.3 | 77 | 64.6 | 41.9 | 37 | 114.9 | 74.6 | 97 | 165.2 | 107.3 | 57 | 215.5 | 140.0 |
| 18 | 15.1 | 9.8 | 78 | 65.4 | 42.5 | 38 | 115.7 | 75.2 | 98 | 166.1 | 107.8 | 58 | 216.4 | 140.5 |
| 19 | 15.9 | 10.3 | 79 | 66.3 | 43.0 | 39 | 116.6 | 75.7 | 99 | 166.9 | 108.4 | 59 | 217.2 | 141.1 |
| 20 | 16.8 | 10.9 | 80 | 67.1 | 43.6 | 40 | 117.4 | 76.2 | 200 | 167.7 | 108.9 | 60 | 218.1 | 141.6 |
| 21 | 17.6 | 11.4 | 81 | 67.9 | 44.1 | 141 | 118.3 | 76.8 | 201 | 168.6 | 109.5 | 261 | 218.9 | 142.2 |
| 22 | 18.5 | 12.0 | 82 | 68.8 | 44.7 | 42 | 119.1 | 77.3 | 02 | 169.4 | 110.0 | 62 | 219.7 | 142.7 |
| 23 | 19.3 | 12.5 | 83 | 69.6 | 45.2 | 43 | 119.9 | 77.9 | 03 | 170.3 | 110.6 | 63 | 220.6 | 143.2 |
| 24 | 20.1 | 13.1 | 84 | 70.4 | 45.7 | 44 | 120.8 | 78.4 | 04 | 171.1 | 111.1 | 64 | 221.4 | 143.8 |
| 25 | 21.0 | 13.6 | 85 | 71.3 | 46.3 | 45 | 121.6 | 79.0 | 05 | 171.9 | 111.7 | 65 | 222.2 | 144.3 |
| 26 | 21.8 | 14.2 | 86 | 72.1 | 46.8 | 46 | 122.4 | 79.5 | 06 | 172.2 | 112.2 | 66 | 223.1 | 144.9 |
| 27 | 22.6 | 14.7 | 87 | 73.0 | 47.4 | 47 | 123.3 | 80.1 | 07 | 173.6 | 112.7 | 67 | 223.9 | 145.4 |
| 28 | 23.5 | 15.2 | 88 | 73.8 | 47.9 | 48 | 124.1 | 80.6 | 08 | 174.4 | 113.3 | 68 | 224.8 | 146.0 |
| 29 | 24.3 | 15.8 | 89 | 74.6 | 48.5 | 49 | 125.0 | 81.2 | 09 | 175.3 | 113.8 | 69 | 225.6 | 146.5 |
| 30 | 25.2 | 16.3 | 90 | 75.5 | 49.0 | 50 | 125.8 | 81.7 | 10 | 176.1 | 114.4 | 70 | 226.4 | 147.1 |
| 31 | 26.0 | 16.9 | 91 | 76.3 | 49.6 | 151 | 126.6 | 82.2 | 211 | 177.0 | 114.9 | 271 | 227.3 | 147.6 |
| 32 | 26.8 | 17.4 | 92 | 77.2 | 50.1 | 52 | 127.5 | 82.8 | 12 | 177.8 | 115.5 | 72 | 228.1 | 148.1 |
| 33 | 27.7 | 18.0 | 93 | 78.0 | 50.7 | 53 | 128.3 | 83.3 | 13 | 178.6 | 116.0 | 73 | 229.0 | 148.7 |
| 34 | 28.5 | 18.5 | 94 | 78.8 | 51.2 | 54 | 129.2 | 83.9 | 14 | 179.5 | 116.6 | 74 | 229.8 | 149.2 |
| 35 | 29.4 | 19.1 | 95 | 79.7 | 51.7 | 55 | 130.0 | 84.4 | 15 | 180.3 | 117.1 | 75 | 230.6 | 149.8 |
| 36 | 30.2 | 19.6 | 96 | 80.5 | 52.3 | 56 | 130.8 | 85.0 | 16 | 181.2 | 117.6 | 76 | 231.5 | 150.3 |
| 37 | 31.0 | 20.2 | 97 | 81.4 | 52.8 | 57 | 131.7 | 85.5 | 17 | 182.0 | 118.2 | 77 | 232.3 | 150.9 |
| 38 | 31.9 | 20.7 | 98 | 82.2 | 53.4 | 58 | 132.5 | 86.1 | 18 | 182.8 | 118.7 | 78 | 233.2 | 151.4 |
| 39 | 32.7 | 21.2 | 99 | 83.0 | 53.9 | 59 | 133.3 | 86.6 | 19 | 183.7 | 119.3 | 79 | 234.0 | 152.0 |
| 40 | 33.5 | 21.8 | 100 | 83.9 | 54.5 | 60 | 134.2 | 87.1 | 20 | 184.5 | 119.8 | 80 | 234.8 | 152.5 |
| 41 | 34.4 | 22.3 | 101 | 84.7 | 55.0 | 161 | 135.0 | 87.7 | 221 | 185.3 | 120.4 | 281 | 235.7 | 153.0 |
| 42 | 35.2 | 22.9 | 02 | 85.5 | 55.6 | 62 | 135.9 | 88.2 | 22 | 186.2 | 120.9 | 82 | 236.5 | 153.6 |
| 43 | 36.1 | 23.4 | 03 | 86.4 | 56.1 | 63 | 136.7 | 88.8 | 23 | 187.0 | 121.5 | 83 | 237.3 | 154.1 |
| 44 | 36.9 | 24.0 | 04 | 87.2 | 56.6 | 64 | 137.5 | 89.3 | 24 | 187.9 | 122.0 | 84 | 238.2 | 154.7 |
| 45 | 37.7 | 24.5 | 05 | 88.1 | 57.2 | 65 | 138.4 | 89.9 | 25 | 188.7 | 122.5 | 85 | 239.0 | 155.2 |
| 46 | 38.6 | 25.1 | 06 | 88.9 | 57.7 | 66 | 139.2 | 90.4 | 26 | 189.5 | 123.1 | 86 | 239.9 | 155.8 |
| 47 | 39.4 | 25.6 | 07 | 89.7 | 58.3 | 67 | 140.1 | 91.0 | 27 | 190.4 | 123.6 | 87 | 240.7 | 156.3 |
| 48 | 40.3 | 26.1 | 08 | 90.6 | 58.8 | 68 | 140.9 | 91.5 | 28 | 191.2 | 124.2 | 88 | 241.5 | 156.9 |
| 49 | 41.1 | 26.7 | 09 | 91.4 | 59.4 | 69 | 141.7 | 92.0 | 29 | 192.1 | 124.7 | 89 | 242.4 | 157.4 |
| 50 | 41.9 | 27.2 | 10 | 92.3 | 59.9 | 70 | 142.6 | 92.6 | 30 | 192.9 | 125.3 | 90 | 243.2 | 157.9 |
| 51 | 42.8 | 27.8 | 111 | 93.1 | 60.5 | 171 | 143.4 | 93.1 | 231 | 193.7 | 125.8 | 291 | 244.1 | 158.5 |
| 52 | 43.6 | 28.3 | 12 | 93.9 | 61.0 | 72 | 144.3 | 93.7 | 32 | 194.6 | 126.4 | 92 | 244.9 | 159.0 |
| 53 | 44.4 | 28.9 | 13 | 94.8 | 61.5 | 73 | 145.1 | 94.2 | 33 | 195.4 | 126.9 | 93 | 245.7 | 159.6 |
| 54 | 45.3 | 29.4 | 14 | 95.6 | 62.1 | 74 | 145.9 | 94.8 | 34 | 196.2 | 127.4 | 94 | 246.6 | 160.1 |
| 55 | 46.1 | 30.0 | 15 | 96.4 | 62.6 | 75 | 146.8 | 95.3 | 35 | 197.1 | 128.0 | 95 | 247.4 | 160.7 |
| 56 | 47.0 | 30.5 | 16 | 97.3 | 63.2 | 76 | 147.6 | 95.9 | 36 | 197.9 | 128.5 | 96 | 248.2 | 161.2 |
| 57 | 47.8 | 31.0 | 17 | 98.1 | 63.7 | 77 | 148.4 | 96.4 | 37 | 198.8 | 129.1 | 97 | 249.1 | 161.8 |
| 58 | 48.6 | 31.6 | 18 | 99.0 | 64.3 | 78 | 149.3 | 96.9 | 38 | 199.6 | 129.6 | 98 | 249.9 | 162.3 |
| 59 | 49.5 | 32.1 | 19 | 99.8 | 64.8 | 79 | 150.1 | 97.5 | 39 | 200.4 | 130.2 | 99 | 250.8 | 162.8 |
| 60 | 50.3 | 32.7 | 20 | 100.6 | 65.4 | 80 | 151.0 | 98.0 | 40 | 201.3 | 130.7 | 300 | 251.6 | 163.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 57° (123°, 237°, 303°).

TABLE 2. [Page 433

Difference of Latitude and Departure for 33° (147°, 213°, 327°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 252.4 | 163.9 | 361 | 302.8 | 196.6 | 421 | 353.1 | 229.3 | 481 | 403.4 | 262.0 | 541 | 453.7 | 294.6 |
| 02 | 253.3 | 164.4 | 62 | 303.6 | 197.1 | 22 | 353.9 | 229.8 | 82 | 404.2 | 262.5 | 42 | 454.6 | 295.2 |
| 03 | 254.1 | 165.0 | 63 | 304.4 | 197.7 | 23 | 354.7 | 230.4 | 83 | 405.1 | 263.1 | 43 | 455.4 | 295.7 |
| 04 | 255.0 | 165.5 | 64 | 305.3 | 198.2 | 24 | 355.6 | 230.9 | 84 | 405.9 | 263.6 | 44 | 456.2 | 296.2 |
| 05 | 255.8 | 166.1 | 65 | 306.1 | 198.8 | 25 | 356.4 | 231.4 | 85 | 406.7 | 264.1 | 45 | 457.1 | 296.8 |
| 06 | 256.6 | 166.6 | 66 | 307.0 | 199.3 | 26 | 357.3 | 232.0 | 86 | 407.6 | 264.7 | 46 | 457.9 | 297.3 |
| 07 | 257.5 | 167.2 | 67 | 307.8 | 199.8 | 27 | 358.1 | 232.5 | 87 | 408.4 | 265.2 | 47 | 458.8 | 297.9 |
| 08 | 258.3 | 167.7 | 68 | 308.6 | 200.4 | 28 | 359.0 | 233.1 | 88 | 409.3 | 265.8 | 48 | 459.6 | 298.4 |
| 09 | 259.2 | 168.3 | 69 | 309.5 | 200.9 | 29 | 359.8 | 233.6 | 89 | 410.1 | 266.3 | 49 | 460.4 | 299.0 |
| 10 | 260.0 | 168.8 | 70 | 310.3 | 201.5 | 30 | 360.6 | 234.2 | 90 | 411.0 | 266.8 | 50 | 461.3 | 299.5 |
| 311 | 260.8 | 169.3 | 371 | 311.2 | 202.0 | 431 | 361.5 | 234.7 | 491 | 411.8 | 267.4 | 551 | 462.1 | 300.1 |
| 12 | 261.7 | 169.9 | 72 | 312.0 | 202.6 | 32 | 362.3 | 235.2 | 92 | 412.6 | 267.9 | 52 | 463.0 | 300.6 |
| 13 | 262.5 | 170.4 | 73 | 312.8 | 203.1 | 33 | 363.1 | 235.8 | 93 | 413.5 | 268.5 | 53 | 463.8 | 301.2 |
| 14 | 263.3 | 171.0 | 74 | 313.7 | 203.7 | 34 | 364.0 | 236.3 | 94 | 414.3 | 269.0 | 54 | 464.6 | 301.7 |
| 15 | 264.2 | 171.5 | 75 | 314.5 | 204.2 | 35 | 364.8 | 236.9 | 95 | 415.1 | 269.6 | 55 | 465.5 | 302.3 |
| 16 | 265.0 | 172.1 | 76 | 315.3 | 204.7 | 36 | 365.7 | 237.4 | 96 | 416.0 | 270.1 | 56 | 466.3 | 302.9 |
| 17 | 265.9 | 172.6 | 77 | 316.2 | 205.3 | 37 | 366.5 | 238.0 | 97 | 416.8 | 270.7 | 57 | 467.2 | 303.4 |
| 18 | 266.7 | 173.2 | 78 | 317.0 | 205.8 | 38 | 367.3 | 238.5 | 98 | 417.6 | 271.2 | 58 | 468.0 | 303.9 |
| 19 | 267.5 | 173.7 | 79 | 317.9 | 206.4 | 39 | 368.2 | 239.1 | 99 | 418.5 | 271.8 | 59 | 468.8 | 304.5 |
| 20 | 268.4 | 174.2 | 80 | 318.7 | 206.9 | 40 | 369.0 | 239.6 | 500 | 419.3 | 272.3 | 60 | 469.7 | 305.0 |
| 321 | 269.2 | 174.8 | 381 | 319.5 | 207.5 | 441 | 369.9 | 240.1 | 501 | 420.2 | 272.8 | 561 | 470.5 | 305.5 |
| 22 | 270.1 | 175.3 | 82 | 320.4 | 208.0 | 42 | 370.7 | 240.7 | 02 | 421.0 | 273.4 | 62 | 471.3 | 306.1 |
| 23 | 270.9 | 175.9 | 83 | 321.2 | 208.6 | 43 | 371.5 | 241.2 | 03 | 421.9 | 273.9 | 63 | 472.2 | 306.6 |
| 24 | 271.7 | 176.4 | 84 | 322.1 | 209.1 | 44 | 372.4 | 241.8 | 04 | 422.7 | 274.5 | 64 | 473.0 | 307.2 |
| 25 | 272.6 | 177.0 | 85 | 322.9 | 209.6 | 45 | 373.2 | 242.3 | 05 | 423.5 | 275.0 | 65 | 473.8 | 307.7 |
| 26 | 273.4 | 177.5 | 86 | 323.7 | 210.2 | 46 | 374.1 | 242.9 | 06 | 424.4 | 275.6 | 66 | 474.7 | 308.3 |
| 27 | 274.2 | 178.1 | 87 | 324.6 | 210.7 | 47 | 374.9 | 243.4 | 07 | 425.2 | 276.1 | 67 | 475.5 | 308.8 |
| 28 | 275.1 | 178.6 | 88 | 325.4 | 211.3 | 48 | 375.7 | 244.0 | 08 | 426.0 | 276.7 | 68 | 476.4 | 309.4 |
| 29 | 275.9 | 179.1 | 89 | 326.2 | 211.8 | 49 | 376.6 | 244.5 | 09 | 426.9 | 277.2 | 69 | 477.2 | 309.9 |
| 30 | 276.8 | 179.7 | 90 | 327.1 | 212.4 | 50 | 377.4 | 245.1 | 10 | 427.7 | 277.8 | 70 | 478.0 | 310.4 |
| 331 | 277.6 | 180.2 | 391 | 327.9 | 212.9 | 451 | 378.2 | 245.6 | 511 | 428.5 | 278.3 | 571 | 478.9 | 311.0 |
| 32 | 278.4 | 180.8 | 92 | 328.8 | 213.5 | 52 | 379.1 | 246.1 | 12 | 429.4 | 278.8 | 72 | 479.7 | 311.5 |
| 33 | 279.3 | 181.3 | 93 | 329.6 | 214.0 | 53 | 379.9 | 246.7 | 13 | 430.2 | 279.4 | 73 | 480.6 | 312.0 |
| 34 | 280.1 | 181.9 | 94 | 330.4 | 214.6 | 54 | 380.8 | 247.2 | 14 | 431.1 | 279.9 | 74 | 481.4 | 312.6 |
| 35 | 281.0 | 182.4 | 95 | 331.3 | 215.1 | 55 | 381.6 | 247.8 | 15 | 431.9 | 280.4 | 75 | 482.2 | 313.1 |
| 36 | 281.8 | 183.0 | 96 | 332.1 | 215.6 | 56 | 382.4 | 248.3 | 16 | 432.7 | 281.0 | 76 | 483.1 | 313.7 |
| 37 | 282.6 | 183.5 | 97 | 333.0 | 216.2 | 57 | 383.3 | 248.9 | 17 | 433.6 | 281.5 | 77 | 483.9 | 314.2 |
| 38 | 283.5 | 184.1 | 98 | 333.8 | 216.7 | 58 | 384.1 | 249.4 | 18 | 434.4 | 282.1 | 78 | 484.7 | 314.8 |
| 39 | 284.3 | 184.6 | 99 | 334.6 | 217.3 | 59 | 385.0 | 250.0 | 19 | 435.3 | 282.6 | 79 | 485.6 | 315.3 |
| 40 | 285.2 | 185.1 | 400 | 335.5 | 217.8 | 60 | 385.8 | 250.5 | 20 | 436.1 | 283.2 | 80 | 486.4 | 315.9 |
| 341 | 286.0 | 185.7 | 401 | 336.3 | 218.4 | 461 | 386.6 | 251.0 | 521 | 436.9 | 283.7 | 581 | 487.2 | 316.4 |
| 42 | 286.8 | 186.2 | 02 | 337.1 | 218.9 | 62 | 387.5 | 251.6 | 22 | 437.8 | 284.3 | 82 | 488.1 | 317.0 |
| 43 | 287.7 | 186.8 | 03 | 338.0 | 219.5 | 63 | 388.3 | 252.1 | 23 | 438.6 | 284.8 | 83 | 488.9 | 317.5 |
| 44 | 288.5 | 187.3 | 04 | 338.8 | 220.0 | 64 | 389.1 | 252.7 | 24 | 439.4 | 285.4 | 84 | 489.8 | 318.1 |
| 45 | 289.3 | 187.9 | 05 | 339.7 | 220.5 | 65 | 390.0 | 253.2 | 25 | 440.3 | 285.9 | 85 | 490.6 | 318.6 |
| 46 | 290.2 | 188.4 | 06 | 340.5 | 221.1 | 66 | 390.8 | 253.8 | 26 | 441.1 | 286.5 | 86 | 491.5 | 319.2 |
| 47 | 291.0 | 189.0 | 07 | 341.3 | 221.6 | 67 | 391.7 | 254.3 | 27 | 442.0 | 287.0 | 87 | 492.3 | 319.7 |
| 48 | 291.9 | 189.5 | 08 | 342.2 | 222.2 | 68 | 392.5 | 254.9 | 28 | 442.8 | 287.5 | 88 | 493.1 | 320.2 |
| 49 | 292.7 | 190.0 | 09 | 343.0 | 222.7 | 69 | 393.3 | 255.4 | 29 | 443.6 | 288.1 | 89 | 494.0 | 320.8 |
| 50 | 293.5 | 190.6 | 10 | 343.9 | 223.3 | 70 | 394.2 | 255.9 | 30 | 444.5 | 288.6 | 90 | 494.8 | 321.3 |
| 351 | 294.4 | 191.1 | 411 | 344.7 | 223.8 | 471 | 395.0 | 256.5 | 531 | 445.3 | 289.2 | 591 | 495.7 | 321.9 |
| 52 | 295.2 | 191.7 | 12 | 345.5 | 224.4 | 72 | 395.8 | 257.0 | 32 | 446.1 | 289.7 | 92 | 496.5 | 322.4 |
| 53 | 296.1 | 192.2 | 13 | 346.4 | 224.9 | 73 | 396.7 | 257.6 | 33 | 447.0 | 290.3 | 93 | 497.3 | 322.9 |
| 54 | 296.9 | 192.8 | 14 | 347.2 | 225.4 | 74 | 397.5 | 258.1 | 34 | 447.8 | 290.8 | 94 | 498.1 | 323.5 |
| 55 | 297.7 | 193.3 | 15 | 348.1 | 226.0 | 75 | 398.3 | 258.7 | 35 | 448.7 | 291.4 | 95 | 499.0 | 324.1 |
| 56 | 298.6 | 193.9 | 16 | 348.9 | 226.5 | 76 | 399.2 | 259.2 | 36 | 449.5 | 291.9 | 96 | 499.8 | 324.6 |
| 57 | 299.4 | 194.4 | 17 | 349.7 | 227.1 | 77 | 400.0 | 259.8 | 37 | 450.3 | 292.5 | 97 | 500.6 | 325.1 |
| 58 | 300.2 | 194.9 | 18 | 350.6 | 227.6 | 78 | 400.9 | 260.3 | 38 | 451.2 | 293.0 | 98 | 501.5 | 325.7 |
| 59 | 301.1 | 195.5 | 19 | 351.4 | 228.2 | 79 | 401.7 | 260.9 | 39 | 452.0 | 293.6 | 99 | 502.3 | 326.2 |
| 60 | 301.9 | 196.0 | 20 | 352.2 | 228.7 | 80 | 402.6 | 261.4 | 40 | 452.9 | 294.1 | 600 | 503.2 | 326.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

57° (123°, 237°, 303°).

# TABLE 2.

Difference of Latitude and Departure for 34° (146°, 214°, 326°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 50.6 | 34.1 | 121 | 100.3 | 67.7 | 181 | 150.1 | 101.2 | 241 | 199.8 | 134.8 |
| 2 | 1.7 | 1.1 | 62 | 51.4 | 34.7 | 22 | 101.1 | 68.2 | 82 | 150.9 | 101.8 | 42 | 200.6 | 135.3 |
| 3 | 2.5 | 1.7 | 63 | 52.2 | 35.2 | 23 | 102.0 | 68.8 | 83 | 151.7 | 102.3 | 43 | 201.5 | 135.9 |
| 4 | 3.3 | 2.2 | 64 | 53.1 | 35.8 | 24 | 102.8 | 69.3 | 84 | 152.5 | 102.9 | 44 | 202.3 | 136.4 |
| 5 | 4.1 | 2.8 | 65 | 53.9 | 36.3 | 25 | 103.6 | 69.9 | 85 | 153.4 | 103.5 | 45 | 203.1 | 137.0 |
| 6 | 5.0 | 3.4 | 66 | 54.7 | 36.9 | 26 | 104.5 | 70.5 | 86 | 154.2 | 104.0 | 46 | 203.9 | 137.6 |
| 7 | 5.8 | 3.9 | 67 | 55.5 | 37.5 | 27 | 105.3 | 71.0 | 87 | 155.0 | 104.6 | 47 | 204.8 | 138.1 |
| 8 | 6.6 | 4.5 | 68 | 56.4 | 38.0 | 28 | 106.1 | 71.6 | 88 | 155.9 | 105.1 | 48 | 205.6 | 138.7 |
| 9 | 7.5 | 5.0 | 69 | 57.2 | 38.6 | 29 | 106.9 | 72.1 | 89 | 156.7 | 105.7 | 49 | 206.4 | 139.2 |
| 10 | 8.3 | 5.6 | 70 | 58.0 | 39.1 | 30 | 107.8 | 72.7 | 90 | 157.5 | 106.2 | 50 | 207.3 | 139.8 |
| 11 | 9.1 | 6.2 | 71 | 58.9 | 39.7 | 131 | 108.6 | 73.3 | 191 | 158.3 | 106.8 | 251 | 208.1 | 140.4 |
| 12 | 9.9 | 6.7 | 72 | 59.7 | 40.3 | 32 | 109.4 | 73.8 | 92 | 159.2 | 107.4 | 52 | 208.9 | 140.9 |
| 13 | 10.8 | 7.3 | 73 | 60.5 | 40.8 | 33 | 110.3 | 74.4 | 93 | 160.0 | 107.9 | 53 | 209.7 | 141.5 |
| 14 | 11.6 | 7.8 | 74 | 61.3 | 41.4 | 34 | 111.1 | 74.9 | 94 | 160.8 | 108.5 | 54 | 210.6 | 142.0 |
| 15 | 12.4 | 8.4 | 75 | 62.2 | 41.9 | 35 | 111.9 | 75.5 | 95 | 161.7 | 109.0 | 55 | 211.4 | 142.6 |
| 16 | 13.3 | 8.9 | 76 | 63.0 | 42.5 | 36 | 112.7 | 76.1 | 96 | 162.5 | 109.6 | 56 | 212.2 | 143.2 |
| 17 | 14.1 | 9.5 | 77 | 63.8 | 43.1 | 37 | 113.6 | 76.6 | 97 | 163.3 | 110.2 | 57 | 213.1 | 143.7 |
| 18 | 14.9 | 10.1 | 78 | 64.7 | 43.6 | 38 | 114.4 | 77.2 | 98 | 164.1 | 110.7 | 58 | 213.9 | 144.3 |
| 19 | 15.8 | 10.6 | 79 | 65.5 | 44.2 | 39 | 115.2 | 77.7 | 99 | 165.0 | 111.3 | 59 | 214.7 | 144.8 |
| 20 | 16.6 | 11.2 | 80 | 66.3 | 44.7 | 40 | 116.1 | 78.3 | 200 | 165.8 | 111.8 | 60 | 215.5 | 145.4 |
| 21 | 17.4 | 11.7 | 81 | 67.2 | 45.3 | 141 | 116.9 | 78.8 | 201 | 166.6 | 112.4 | 261 | 216.4 | 145.9 |
| 22 | 18.2 | 12.3 | 82 | 68.0 | 45.9 | 42 | 117.7 | 79.4 | 02 | 167.5 | 113.0 | 62 | 217.2 | 146.5 |
| 23 | 19.1 | 12.9 | 83 | 68.8 | 46.4 | 43 | 118.6 | 80.0 | 03 | 168.3 | 113.5 | 63 | 218.0 | 147.1 |
| 24 | 19.9 | 13.4 | 84 | 69.6 | 47.0 | 44 | 119.4 | 80.5 | 04 | 169.1 | 114.1 | 64 | 218.9 | 147.6 |
| 25 | 20.7 | 14.0 | 85 | 70.5 | 47.5 | 45 | 120.2 | 81.1 | 05 | 170.0 | 114.6 | 65 | 219.7 | 148.2 |
| 26 | 21.6 | 14.5 | 86 | 71.3 | 48.1 | 46 | 121.0 | 81.6 | 06 | 170.8 | 115.2 | 66 | 220.5 | 148.7 |
| 27 | 22.4 | 15.1 | 87 | 72.1 | 48.6 | 47 | 121.9 | 82.2 | 07 | 171.6 | 115.8 | 67 | 221.4 | 149.3 |
| 28 | 23.2 | 15.7 | 88 | 73.0 | 49.2 | 48 | 122.7 | 82.8 | 08 | 172.4 | 116.3 | 68 | 222.2 | 149.9 |
| 29 | 24.0 | 16.2 | 89 | 73.8 | 49.8 | 49 | 123.5 | 83.3 | 09 | 173.3 | 116.9 | 69 | 223.0 | 150.4 |
| 30 | 24.9 | 16.8 | 90 | 74.6 | 50.3 | 50 | 124.4 | 83.9 | 10 | 174.1 | 117.4 | 70 | 223.8 | 151.0 |
| 31 | 25.7 | 17.3 | 91 | 75.4 | 50.9 | 151 | 125.2 | 84.4 | 211 | 174.9 | 118.0 | 271 | 224.7 | 151.5 |
| 32 | 26.5 | 17.9 | 92 | 76.3 | 51.4 | 52 | 126.0 | 85.0 | 12 | 175.8 | 118.5 | 72 | 225.5 | 152.1 |
| 33 | 27.4 | 18.5 | 93 | 77.1 | 52.0 | 53 | 126.8 | 85.6 | 13 | 176.6 | 119.1 | 73 | 226.3 | 152.7 |
| 34 | 28.2 | 19.0 | 94 | 77.9 | 52.6 | 54 | 127.7 | 86.1 | 14 | 177.4 | 119.7 | 74 | 227.2 | 153.2 |
| 35 | 29.0 | 19.6 | 95 | 78.8 | 53.1 | 55 | 128.5 | 86.7 | 15 | 178.2 | 120.2 | 75 | 228.0 | 153.8 |
| 36 | 29.8 | 20.1 | 96 | 79.6 | 53.7 | 56 | 129.3 | 87.2 | 16 | 179.1 | 120.8 | 76 | 228.8 | 154.3 |
| 37 | 30.7 | 20.7 | 97 | 80.4 | 54.2 | 57 | 130.2 | 87.8 | 17 | 179.9 | 121.3 | 77 | 229.6 | 154.9 |
| 38 | 31.5 | 21.2 | 98 | 81.2 | 54.8 | 58 | 131.0 | 88.4 | 18 | 180.7 | 121.9 | 78 | 230.5 | 155.5 |
| 39 | 32.3 | 21.8 | 99 | 82.1 | 55.4 | 59 | 131.8 | 88.9 | 19 | 181.6 | 122.5 | 79 | 231.3 | 156.0 |
| 40 | 33.2 | 22.4 | 100 | 82.9 | 55.9 | 60 | 132.6 | 89.5 | 20 | 182.4 | 123.0 | 80 | 232.1 | 156.6 |
| 41 | 34.0 | 22.9 | 101 | 83.7 | 56.5 | 161 | 133.5 | 90.0 | 221 | 183.2 | 123.6 | 281 | 233.0 | 157.1 |
| 42 | 34.8 | 23.5 | 02 | 84.6 | 57.0 | 62 | 134.3 | 90.6 | 22 | 184.0 | 124.1 | 82 | 233.8 | 157.7 |
| 43 | 35.6 | 24.0 | 03 | 85.4 | 57.6 | 63 | 135.1 | 91.1 | 23 | 184.9 | 124.7 | 83 | 234.6 | 158.3 |
| 44 | 36.5 | 24.6 | 04 | 86.2 | 58.2 | 64 | 136.0 | 91.7 | 24 | 185.7 | 125.3 | 84 | 235.4 | 158.8 |
| 45 | 37.3 | 25.2 | 05 | 87.0 | 58.7 | 65 | 136.8 | 92.3 | 25 | 186.5 | 125.8 | 85 | 236.3 | 159.4 |
| 46 | 38.1 | 25.7 | 06 | 87.9 | 59.3 | 66 | 137.6 | 92.8 | 26 | 187.4 | 126.4 | 86 | 237.1 | 159.9 |
| 47 | 39.0 | 26.3 | 07 | 88.7 | 59.8 | 67 | 138.4 | 93.4 | 27 | 188.2 | 126.9 | 87 | 237.9 | 160.5 |
| 48 | 39.8 | 26.8 | 08 | 89.5 | 60.4 | 68 | 139.3 | 93.9 | 28 | 189.0 | 127.5 | 88 | 238.8 | 161.0 |
| 49 | 40.6 | 27.4 | 09 | 90.4 | 61.0 | 69 | 140.1 | 94.5 | 29 | 189.8 | 128.1 | 89 | 239.6 | 161.6 |
| 50 | 41.5 | 28.0 | 10 | 91.2 | 61.5 | 70 | 140.9 | 95.1 | 30 | 190.7 | 128.6 | 90 | 240.4 | 162.2 |
| 51 | 42.3 | 28.5 | 111 | 92.0 | 62.1 | 171 | 141.8 | 95.6 | 231 | 191.5 | 129.2 | 291 | 241.2 | 162.7 |
| 52 | 43.1 | 29.1 | 12 | 92.9 | 62.6 | 72 | 142.6 | 96.2 | 32 | 192.3 | 129.7 | 92 | 242.1 | 163.3 |
| 53 | 43.9 | 29.6 | 13 | 93.7 | 63.2 | 73 | 143.4 | 96.7 | 33 | 193.2 | 130.3 | 93 | 242.9 | 163.8 |
| 54 | 44.8 | 30.2 | 14 | 94.5 | 63.7 | 74 | 144.3 | 97.3 | 34 | 194.0 | 130.9 | 94 | 243.7 | 164.4 |
| 55 | 45.6 | 30.8 | 15 | 95.3 | 64.3 | 75 | 145.1 | 97.9 | 35 | 194.8 | 131.4 | 95 | 244.6 | 165.0 |
| 56 | 46.4 | 31.3 | 16 | 96.2 | 64.9 | 76 | 145.9 | 98.4 | 36 | 195.7 | 132.0 | 96 | 245.4 | 165.5 |
| 57 | 47.3 | 31.9 | 17 | 97.0 | 65.4 | 77 | 146.7 | 99.0 | 37 | 196.5 | 132.5 | 97 | 246.2 | 166.1 |
| 58 | 48.1 | 32.4 | 18 | 97.8 | 66.0 | 78 | 147.6 | 99.5 | 38 | 197.3 | 133.1 | 98 | 247.1 | 166.6 |
| 59 | 48.9 | 33.0 | 19 | 98.7 | 66.5 | 79 | 148.4 | 100.1 | 39 | 198.1 | 133.6 | 99 | 247.9 | 167.2 |
| 60 | 49.7 | 33.6 | 20 | 99.5 | 67.1 | 80 | 149.2 | 100.7 | 40 | 199.0 | 134.2 | 300 | 248.7 | 167.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

56° (124°, 236°, 304°).

TABLE 2. [Page 435

Difference of Latitude and Departure for 34° (146°, 214°, 326°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 249.5 | 168.3 | 361 | 299.3 | 201.9 | 421 | 349.0 | 235.4 | 481 | 398.8 | 269.0 | 541 | 448.5 | 302.5 |
| 02 | 250.4 | 168.9 | 62 | 300.1 | 202.4 | 22 | 349.9 | 236.0 | 82 | 399.6 | 269.5 | 42 | 449.4 | 303.1 |
| 03 | 251.2 | 169.4 | 63 | 300.9 | 203.0 | 23 | 350.7 | 236.5 | 83 | 400.4 | 270.1 | 43 | 450.2 | 303.6 |
| 04 | 252.0 | 170.0 | 64 | 301.8 | 203.5 | 24 | 351.5 | 237.1 | 84 | 401.3 | 270.6 | 44 | 451.0 | 304.2 |
| 05 | 252.9 | 170.6 | 65 | 302.6 | 204.1 | 25 | 352.3 | 237.7 | 85 | 402.1 | 271.2 | 45 | 451.8 | 304.8 |
| 06 | 253.7 | 171.1 | 66 | 303.4 | 204.7 | 26 | 353.2 | 238.2 | 86 | 402.9 | 271.8 | 46 | 452.6 | 305.3 |
| 07 | 254.5 | 171.7 | 67 | 304.3 | 205.2 | 27 | 354.0 | 238.8 | 87 | 403.8 | 272.3 | 47 | 453.5 | 305.9 |
| 08 | 255.3 | 172.2 | 68 | 305.1 | 205.8 | 28 | 354.8 | 239.3 | 88 | 404.6 | 272.8 | 48 | 454.3 | 306.4 |
| 09 | 256.2 | 172.8 | 69 | 305.9 | 206.3 | 29 | 355.7 | 239.9 | 89 | 405.4 | 273.4 | 49 | 455.2 | 307.0 |
| 10 | 257.0 | 173.3 | 70 | 306.7 | 206.9 | 30 | 356.5 | 240.4 | 90 | 406.2 | 274.0 | 50 | 456.0 | 307.5 |
| 311 | 257.8 | 173.9 | 371 | 307.6 | 207.5 | 431 | 357.3 | 241.0 | 491 | 407.1 | 274.6 | 551 | 456.8 | 308.1 |
| 12 | 258.7 | 174.5 | 72 | 308.4 | 208.0 | 32 | 358.1 | 241.6 | 92 | 407.9 | 275.1 | 52 | 457.6 | 308.7 |
| 13 | 259.5 | 175.0 | 73 | 309.2 | 208.6 | 33 | 359.0 | 242.1 | 93 | 408.7 | 275.7 | 53 | 458.4 | 309.2 |
| 14 | 260.3 | 175.6 | 74 | 310.1 | 209.1 | 34 | 359.8 | 242.7 | 94 | 409.5 | 276.2 | 54 | 459.3 | 309.8 |
| 15 | 261.2 | 176.1 | 75 | 310.9 | 209.7 | 35 | 360.6 | 243.2 | 95 | 410.4 | 276.8 | 55 | 460.1 | 310.3 |
| 16 | 262.0 | 176.7 | 76 | 311.7 | 210.3 | 36 | 361.5 | 243.8 | 96 | 411.2 | 277.4 | 56 | 460.9 | 310.9 |
| 17 | 262.8 | 177.3 | 77 | 312.6 | 210.8 | 37 | 362.3 | 244.4 | 97 | 412.0 | 277.9 | 57 | 461.7 | 311.5 |
| 18 | 263.7 | 177.8 | 78 | 313.4 | 211.4 | 38 | 363.1 | 244.9 | 98 | 412.8 | 278.4 | 58 | 462.6 | 312.0 |
| 19 | 264.5 | 178.4 | 79 | 314.2 | 211.9 | 39 | 364.0 | 245.5 | 99 | 413.7 | 279.0 | 59 | 463.4 | 312.6 |
| 20 | 265.3 | 178.9 | 80 | 315.0 | 212.5 | 40 | 364.8 | 246.0 | 500 | 414.5 | 279.6 | 60 | 464.2 | 313.1 |
| 321 | 266.1 | 179.5 | 381 | 315.9 | 213.0 | 441 | 365.6 | 246.6 | 501 | 415.3 | 280.1 | 561 | 465.1 | 313.7 |
| 22 | 267.0 | 180.1 | 82 | 316.7 | 213.6 | 42 | 366.4 | 247.2 | 02 | 416.2 | 280.7 | 62 | 465.9 | 314.3 |
| 23 | 267.8 | 180.6 | 83 | 317.5 | 214.2 | 43 | 367.3 | 247.7 | 03 | 417.0 | 281.3 | 63 | 466.8 | 314.8 |
| 24 | 268.6 | 181.2 | 84 | 318.4 | 214.7 | 44 | 368.1 | 248.3 | 04 | 417.8 | 281.8 | 64 | 467.6 | 315.4 |
| 25 | 269.5 | 181.7 | 85 | 319.2 | 215.3 | 45 | 368.9 | 248.8 | 05 | 418.6 | 282.4 | 65 | 468.4 | 315.9 |
| 26 | 270.3 | 182.3 | 86 | 320.0 | 215.8 | 46 | 369.8 | 249.4 | 06 | 419.4 | 282.9 | 66 | 469.2 | 316.5 |
| 27 | 271.1 | 182.9 | 87 | 320.8 | 216.4 | 47 | 370.6 | 250.0 | 07 | 420.3 | 283.5 | 67 | 470.1 | 317.1 |
| 28 | 271.9 | 183.4 | 88 | 321.7 | 217.0 | 48 | 371.4 | 250.5 | 08 | 421.1 | 284.1 | 68 | 470.9 | 317.6 |
| 29 | 272.8 | 184.0 | 89 | 322.5 | 217.5 | 49 | 372.2 | 251.1 | 09 | 421.9 | 284.6 | 69 | 471.7 | 318.2 |
| 30 | 273.6 | 184.5 | 90 | 323.3 | 218.1 | 50 | 373.1 | 251.6 | 10 | 422.8 | 285.2 | 70 | 472.6 | 318.7 |
| 331 | 274.4 | 185.1 | 391 | 324.2 | 218.6 | 451 | 373.9 | 252.2 | 511 | 423.6 | 285.8 | 571 | 473.4 | 319.3 |
| 32 | 275.2 | 185.6 | 92 | 325.0 | 219.2 | 52 | 374.7 | 252.8 | 12 | 424.4 | 286.3 | 72 | 474.2 | 319.9 |
| 33 | 276.1 | 186.2 | 93 | 325.8 | 219.8 | 53 | 375.6 | 253.3 | 13 | 425.3 | 286.9 | 73 | 475.0 | 320.4 |
| 34 | 276.9 | 186.8 | 94 | 326.6 | 220.3 | 54 | 376.4 | 253.9 | 14 | 426.1 | 287.4 | 74 | 475.9 | 321.0 |
| 35 | 277.7 | 187.3 | 95 | 327.5 | 220.9 | 55 | 377.2 | 254.4 | 15 | 426.9 | 288.0 | 75 | 476.7 | 321.5 |
| 36 | 278.6 | 187.9 | 96 | 328.3 | 221.4 | 56 | 378.0 | 255.0 | 16 | 427.8 | 288.5 | 76 | 477.5 | 322.1 |
| 37 | 279.4 | 188.4 | 97 | 329.1 | 222.0 | 57 | 378.9 | 255.5 | 17 | 428.6 | 289.1 | 77 | 478.3 | 322.7 |
| 38 | 280.2 | 189.0 | 98 | 330.0 | 222.6 | 58 | 379.7 | 256.1 | 18 | 429.4 | 289.6 | 78 | 479.2 | 323.2 |
| 39 | 281.0 | 189.6 | 99 | 330.8 | 223.1 | 59 | 380.5 | 256.7 | 19 | 430.3 | 290.2 | 79 | 480.0 | 323.8 |
| 40 | 281.9 | 190.1 | 400 | 331.6 | 223.7 | 60 | 381.3 | 257.2 | 20 | 431.1 | 290.8 | 80 | 480.8 | 324.3 |
| 341 | 282.7 | 190.7 | 401 | 332.4 | 224.2 | 461 | 382.2 | 257.8 | 521 | 431.9 | 291.3 | 581 | 481.6 | 324.9 |
| 42 | 283.5 | 191.2 | 02 | 333.3 | 224.8 | 62 | 383.0 | 258.3 | 22 | 432.8 | 291.9 | 82 | 482.5 | 325.4 |
| 43 | 284.4 | 191.8 | 03 | 334.1 | 225.4 | 63 | 383.8 | 258.9 | 23 | 433.6 | 292.5 | 83 | 483.3 | 326.0 |
| 44 | 285.2 | 192.4 | 04 | 334.9 | 225.9 | 64 | 384.7 | 259.5 | 24 | 434.4 | 293.0 | 84 | 484.1 | 326.6 |
| 45 | 286.0 | 192.9 | 05 | 335.8 | 226.5 | 65 | 385.5 | 260.0 | 25 | 435.3 | 293.6 | 85 | 485.0 | 327.2 |
| 46 | 286.9 | 193.5 | 06 | 336.6 | 227.0 | 66 | 386.3 | 260.6 | 26 | 436.1 | 294.1 | 86 | 485.8 | 327.7 |
| 47 | 287.7 | 194.0 | 07 | 337.4 | 227.6 | 67 | 387.2 | 261.1 | 27 | 436.9 | 294.7 | 87 | 486.6 | 328.2 |
| 48 | 288.5 | 194.6 | 08 | 338.3 | 228.1 | 68 | 388.0 | 261.7 | 28 | 437.8 | 295.3 | 88 | 487.5 | 328.8 |
| 49 | 289.3 | 195.2 | 09 | 339.1 | 228.7 | 69 | 388.8 | 262.3 | 29 | 438.6 | 295.8 | 89 | 488.3 | 329.4 |
| 50 | 290.2 | 195.7 | 10 | 339.9 | 229.3 | 70 | 389.7 | 262.8 | 30 | 439.4 | 296.4 | 90 | 489.2 | 329.9 |
| 351 | 291.0 | 196.3 | 411 | 340.7 | 229.8 | 471 | 390.5 | 263.4 | 531 | 440.3 | 296.9 | 591 | 490.0 | 330.5 |
| 52 | 291.8 | 196.8 | 12 | 341.6 | 230.4 | 72 | 391.3 | 263.9 | 32 | 441.1 | 297.4 | 92 | 490.8 | 331.0 |
| 53 | 292.7 | 197.4 | 13 | 342.4 | 230.9 | 73 | 392.1 | 264.5 | 33 | 441.9 | 298.0 | 93 | 491.6 | 331.6 |
| 54 | 293.5 | 198.0 | 14 | 343.2 | 231.5 | 74 | 393.0 | 265.0 | 34 | 442.7 | 298.6 | 94 | 492.5 | 332.2 |
| 55 | 294.3 | 198.5 | 15 | 344.1 | 232.1 | 75 | 393.8 | 265.6 | 35 | 443.6 | 299.1 | 95 | 493.3 | 332.7 |
| 56 | 295.1 | 199.1 | 16 | 344.9 | 232.6 | 76 | 394.6 | 266.2 | 36 | 444.4 | 299.7 | 96 | 494.1 | 333.3 |
| 57 | 296.0 | 199.6 | 17 | 345.7 | 233.2 | 77 | 395.5 | 266.7 | 37 | 445.3 | 300.2 | 97 | 494.9 | 333.8 |
| 58 | 296.8 | 200.2 | 18 | 346.5 | 233.7 | 78 | 396.3 | 267.3 | 38 | 446.1 | 300.8 | 98 | 495.8 | 334.4 |
| 59 | 297.6 | 200.7 | 19 | 347.4 | 234.3 | 79 | 397.1 | 267.9 | 39 | 446.9 | 301.4 | 99 | 496.6 | 334.9 |
| 60 | 298.5 | 201.3 | 20 | 348.2 | 234.9 | 80 | 397.9 | 268.4 | 40 | 447.7 | 302.0 | 600 | 497.4 | 335.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

56° (124°, 236°, 304°).

# TABLE 2.

### Difference of Latitude and Departure for 35° (145°, 215°, 325°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 50.0 | 35.0 | 121 | 99.1 | 69.4 | 181 | 148.3 | 103.8 | 241 | 197.4 | 138.2 |
| 2 | 1.6 | 1.1 | 62 | 50.8 | 35.6 | 22 | 99.9 | 70.0 | 82 | 149.1 | 104.4 | 42 | 198.2 | 138.8 |
| 3 | 2.5 | 1.7 | 63 | 51.6 | 36.1 | 23 | 100.8 | 70.5 | 83 | 149.9 | 105.0 | 43 | 199.1 | 139.4 |
| 4 | 3.3 | 2.3 | 64 | 52.4 | 36.7 | 24 | 101.6 | 71.1 | 84 | 150.7 | 105.5 | 44 | 199.9 | 140.0 |
| 5 | 4.1 | 2.9 | 65 | 53.2 | 37.3 | 25 | 102.4 | 71.7 | 85 | 151.5 | 106.1 | 45 | 200.7 | 140.5 |
| 6 | 4.9 | 3.4 | 66 | 54.1 | 37.9 | 26 | 103.2 | 72.3 | 86 | 152.4 | 106.7 | 46 | 201.5 | 141.1 |
| 7 | 5.7 | 4.0 | 67 | 54.9 | 38.4 | 27 | 104.0 | 72.8 | 87 | 153.2 | 107.3 | 47 | 202.3 | 141.7 |
| 8 | 6.6 | 4.6 | 68 | 55.7 | 39.0 | 28 | 104.9 | 73.4 | 88 | 154.0 | 107.8 | 48 | 203.1 | 142.2 |
| 9 | 7.4 | 5.2 | 69 | 56.5 | 39.6 | 29 | 105.7 | 74.0 | 89 | 154.8 | 108.4 | 49 | 204.0 | 142.8 |
| 10 | 8.2 | 5.7 | 70 | 57.3 | 40.2 | 30 | 106.5 | 74.6 | 90 | 155.6 | 109.0 | 50 | 204.8 | 143.4 |
| 11 | 9.0 | 6.3 | 71 | 58.2 | 40.7 | 131 | 107.3 | 75.1 | 191 | 156.5 | 109.6 | 251 | 205.6 | 144.0 |
| 12 | 9.8 | 6.9 | 72 | 59.0 | 41.3 | 32 | 108.1 | 75.7 | 92 | 157.3 | 110.1 | 52 | 206.4 | 144.5 |
| 13 | 10.6 | 7.5 | 73 | 59.8 | 41.9 | 33 | 108.9 | 76.3 | 93 | 158.1 | 110.7 | 53 | 207.2 | 145.1 |
| 14 | 11.5 | 8.0 | 74 | 60.6 | 42.4 | 34 | 109.8 | 76.9 | 94 | 158.9 | 111.3 | 54 | 208.1 | 145.7 |
| 15 | 12.3 | 8.6 | 75 | 61.4 | 43.0 | 35 | 110.6 | 77.4 | 95 | 159.7 | 111.8 | 55 | 208.9 | 146.3 |
| 16 | 13.1 | 9.2 | 76 | 62.3 | 43.6 | 36 | 111.4 | 78.0 | 96 | 160.6 | 112.4 | 56 | 209.7 | 146.8 |
| 17 | 13.9 | 9.8 | 77 | 63.1 | 44.2 | 37 | 112.2 | 78.6 | 97 | 161.4 | 113.0 | 57 | 210.5 | 147.4 |
| 18 | 14.7 | 10.3 | 78 | 63.9 | 44.7 | 38 | 113.0 | 79.2 | 98 | 162.2 | 113.6 | 58 | 211.3 | 148.0 |
| 19 | 15.6 | 10.9 | 79 | 64.7 | 45.3 | 39 | 113.9 | 79.7 | 99 | 163.0 | 114.1 | 59 | 212.2 | 148.6 |
| 20 | 16.4 | 11.5 | 80 | 65.5 | 45.9 | 40 | 114.7 | 80.3 | 200 | 163.8 | 114.7 | 60 | 213.0 | 149.1 |
| 21 | 17.2 | 12.0 | 81 | 66.4 | 46.5 | 141 | 115.5 | 80.9 | 201 | 164.6 | 115.3 | 261 | 213.8 | 149.7 |
| 22 | 18.0 | 12.6 | 82 | 67.2 | 47.0 | 42 | 116.3 | 81.4 | 02 | 165.5 | 115.9 | 62 | 214.6 | 150.3 |
| 23 | 18.8 | 13.2 | 83 | 68.0 | 47.6 | 43 | 117.1 | 82.0 | 03 | 166.3 | 116.4 | 63 | 215.4 | 150.9 |
| 24 | 19.7 | 13.8 | 84 | 68.8 | 48.2 | 44 | 118.0 | 82.6 | 04 | 167.1 | 117.0 | 64 | 216.3 | 151.4 |
| 25 | 20.5 | 14.3 | 85 | 69.6 | 48.8 | 45 | 118.8 | 83.2 | 05 | 167.9 | 117.6 | 65 | 217.1 | 152.0 |
| 26 | 21.3 | 14.9 | 86 | 70.4 | 49.3 | 46 | 119.6 | 83.7 | 06 | 168.7 | 118.2 | 66 | 217.9 | 152.6 |
| 27 | 22.1 | 15.5 | 87 | 71.3 | 49.9 | 47 | 120.4 | 84.3 | 07 | 169.6 | 118.7 | 67 | 218.7 | 153.1 |
| 28 | 22.9 | 16.1 | 88 | 72.1 | 50.5 | 48 | 121.2 | 84.9 | 08 | 170.4 | 119.3 | 68 | 219.5 | 153.7 |
| 29 | 23.8 | 16.6 | 89 | 72.9 | 51.0 | 49 | 122.1 | 85.5 | 09 | 171.2 | 119.9 | 69 | 220.4 | 154.3 |
| 30 | 24.6 | 17.2 | 90 | 73.7 | 51.6 | 50 | 122.9 | 86.0 | 10 | 172.0 | 120.5 | 70 | 221.2 | 154.9 |
| 31 | 25.4 | 17.8 | 91 | 74.5 | 52.2 | 151 | 123.7 | 86.6 | 211 | 172.8 | 121.0 | 271 | 222.0 | 155.4 |
| 32 | 26.2 | 18.4 | 92 | 75.4 | 52.8 | 52 | 124.5 | 87.2 | 12 | 173.7 | 121.6 | 72 | 222.8 | 156.0 |
| 33 | 27.0 | 18.9 | 93 | 76.2 | 53.3 | 53 | 125.3 | 87.8 | 13 | 174.5 | 122.2 | 73 | 223.6 | 156.6 |
| 34 | 27.9 | 19.5 | 94 | 77.0 | 53.9 | 54 | 126.1 | 88.3 | 14 | 175.3 | 122.7 | 74 | 224.4 | 157.2 |
| 35 | 28.7 | 20.1 | 95 | 77.8 | 54.5 | 55 | 127.0 | 88.9 | 15 | 176.1 | 123.3 | 75 | 225.3 | 157.7 |
| 36 | 29.5 | 20.6 | 96 | 78.6 | 55.1 | 56 | 127.8 | 89.5 | 16 | 176.9 | 123.9 | 76 | 226.1 | 158.3 |
| 37 | 30.3 | 21.2 | 97 | 79.5 | 55.6 | 57 | 128.6 | 90.1 | 17 | 177.8 | 124.5 | 77 | 226.9 | 158.9 |
| 38 | 31.1 | 21.8 | 98 | 80.3 | 56.2 | 58 | 129.4 | 90.6 | 18 | 178.6 | 125.0 | 78 | 227.7 | 159.5 |
| 39 | 31.9 | 22.4 | 99 | 81.1 | 56.8 | 59 | 130.2 | 91.2 | 19 | 179.4 | 125.6 | 79 | 228.5 | 160.0 |
| 40 | 32.8 | 22.9 | 100 | 81.9 | 57.4 | 60 | 131.1 | 91.8 | 20 | 180.2 | 126.2 | 80 | 229.4 | 160.6 |
| 41 | 33.6 | 23.5 | 101 | 82.7 | 57.9 | 161 | 131.9 | 92.3 | 221 | 181.0 | 126.8 | 281 | 230.2 | 161.2 |
| 42 | 34.4 | 24.1 | 02 | 83.6 | 58.5 | 62 | 132.7 | 92.9 | 22 | 181.9 | 127.3 | 82 | 231.0 | 161.7 |
| 43 | 35.2 | 24.7 | 03 | 84.4 | 59.1 | 63 | 133.5 | 93.5 | 23 | 182.7 | 127.9 | 83 | 231.8 | 162.3 |
| 44 | 36.0 | 25.2 | 04 | 85.2 | 59.7 | 64 | 134.3 | 94.1 | 24 | 183.5 | 128.5 | 84 | 232.6 | 162.9 |
| 45 | 36.9 | 25.8 | 05 | 86.0 | 60.2 | 65 | 135.2 | 94.6 | 25 | 184.3 | 129.1 | 85 | 233.5 | 163.5 |
| 46 | 37.7 | 26.4 | 06 | 86.8 | 60.8 | 66 | 136.0 | 95.2 | 26 | 185.1 | 129.6 | 86 | 234.3 | 164.0 |
| 47 | 38.5 | 27.0 | 07 | 87.6 | 61.4 | 67 | 136.8 | 95.8 | 27 | 185.9 | 130.2 | 87 | 235.1 | 164.6 |
| 48 | 39.3 | 27.5 | 08 | 88.5 | 61.9 | 68 | 137.6 | 96.4 | 28 | 186.8 | 130.8 | 88 | 235.9 | 165.2 |
| 49 | 40.1 | 28.1 | 09 | 89.3 | 62.5 | 69 | 138.4 | 96.9 | 29 | 187.6 | 131.3 | 89 | 236.7 | 165.8 |
| 50 | 41.0 | 28.7 | 10 | 90.1 | 63.1 | 70 | 139.3 | 97.5 | 30 | 188.4 | 131.9 | 90 | 237.6 | 166.3 |
| 51 | 41.8 | 29.3 | 111 | 90.9 | 63.7 | 171 | 140.1 | 98.1 | 231 | 189.2 | 132.5 | 291 | 238.4 | 166.9 |
| 52 | 42.6 | 29.8 | 12 | 91.7 | 64.2 | 72 | 140.9 | 98.7 | 32 | 190.0 | 133.1 | 92 | 239.2 | 167.5 |
| 53 | 43.4 | 30.4 | 13 | 92.6 | 64.8 | 73 | 141.7 | 99.2 | 33 | 190.9 | 133.6 | 93 | 240.0 | 168.1 |
| 54 | 44.2 | 31.0 | 14 | 93.4 | 65.4 | 74 | 142.5 | 99.8 | 34 | 191.7 | 134.2 | 94 | 240.8 | 168.6 |
| 55 | 45.1 | 31.5 | 15 | 94.2 | 66.0 | 75 | 143.4 | 100.4 | 35 | 192.5 | 134.8 | 95 | 241.6 | 169.2 |
| 56 | 45.9 | 32.1 | 16 | 95.0 | 66.5 | 76 | 144.2 | 100.9 | 36 | 193.3 | 135.4 | 96 | 242.5 | 169.8 |
| 57 | 46.7 | 32.7 | 17 | 95.8 | 67.1 | 77 | 145.0 | 101.5 | 37 | 194.1 | 135.9 | 97 | 243.3 | 170.4 |
| 58 | 47.5 | 33.3 | 18 | 96.7 | 67.7 | 78 | 145.8 | 102.1 | 38 | 195.0 | 136.5 | 98 | 244.1 | 170.9 |
| 59 | 48.3 | 33.8 | 19 | 97.5 | 68.3 | 79 | 146.6 | 102.7 | 39 | 195.8 | 137.1 | 99 | 244.9 | 171.5 |
| 60 | 49.1 | 34.4 | 20 | 98.3 | 68.8 | 80 | 147.4 | 103.2 | 40 | 196.6 | 137.7 | 300 | 245.7 | 172.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

### 55° (125°, 235°, 305°).

# TABLE 2.

Difference of Latitude and Departure for 35° (145°, 215°, 325°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 246.6 | 172.6 | 361 | 295.7 | 207.0 | 421 | 344.9 | 241.5 | 481 | 394.0 | 275.9 | 541 | 443.2 | 310.3 |
| 02 | 247.4 | 173.2 | 62 | 296.5 | 207.6 | 22 | 345.7 | 242.0 | 82 | 394.8 | 276.4 | 42 | 444.0 | 310.9 |
| 03 | 248.2 | 173.8 | 63 | 297.4 | 208.2 | 23 | 346.5 | 242.6 | 83 | 395.7 | 277.0 | 43 | 444.8 | 311.4 |
| 04 | 249.0 | 174.3 | 64 | 298.2 | 208.8 | 24 | 347.3 | 243.2 | 84 | 396.5 | 277.6 | 44 | 445.6 | 312.0 |
| 05 | 249.9 | 174.9 | 65 | 299.0 | 209.3 | 25 | 348.1 | 243.8 | 85 | 397.3 | 278.2 | 45 | 446.4 | 312.6 |
| 06 | 250.7 | 175.5 | 66 | 299.8 | 209.9 | 26 | 349.0 | 244.3 | 86 | 398.1 | 278.7 | 46 | 447.3 | 313.2 |
| 07 | 251.5 | 176.1 | 67 | 300.6 | 210.5 | 27 | 349.8 | 244.9 | 87 | 398.9 | 279.3 | 47 | 448.1 | 313.7 |
| 08 | 252.3 | 176.6 | 68 | 301.5 | 211.1 | 28 | 350.6 | 245.5 | 88 | 399.8 | 279.9 | 48 | 448.9 | 314.3 |
| 09 | 253.1 | 177.2 | 69 | 302.3 | 211.6 | 29 | 351.4 | 246.0 | 89 | 400.6 | 280.5 | 49 | 449.7 | 314.9 |
| 10 | 253.9 | 177.8 | 70 | 303.1 | 212.2 | 30 | 352.2 | 246.6 | 90 | 401.4 | 281.0 | 50 | 450.5 | 315.4 |
| 311 | 254.8 | 178.4 | 371 | 303.9 | 212.8 | 431 | 353.1 | 247.2 | 491 | 402.2 | 281.6 | 551 | 451.4 | 316.0 |
| 12 | 255.6 | 178.9 | 72 | 304.7 | 213.4 | 32 | 353.9 | 247.8 | 92 | 403.0 | 282.2 | 52 | 452.2 | 316.6 |
| 13 | 256.4 | 179.5 | 73 | 305.6 | 213.9 | 33 | 354.7 | 248.3 | 93 | 403.9 | 282.8 | 53 | 453.0 | 317.2 |
| 14 | 257.2 | 180.1 | 74 | 306.4 | 214.5 | 34 | 355.5 | 248.9 | 94 | 404.7 | 283.3 | 54 | 453.8 | 317.7 |
| 15 | 258.0 | 180.7 | 75 | 307.2 | 215.1 | 35 | 356.3 | 249.5 | 95 | 405.5 | 283.9 | 55 | 454.6 | 318.3 |
| 16 | 258.9 | 181.2 | 76 | 308.0 | 215.6 | 36 | 357.2 | 250.1 | 96 | 406.3 | 284.5 | 56 | 455.5 | 318.9 |
| 17 | 259.7 | 181.8 | 77 | 308.8 | 216.2 | 37 | 358.0 | 250.6 | 97 | 407.1 | 285.1 | 57 | 456.3 | 319.5 |
| 18 | 260.5 | 182.4 | 78 | 309.6 | 216.8 | 38 | 358.8 | 251.2 | 98 | 408.0 | 285.6 | 58 | 457.1 | 320.0 |
| 19 | 261.3 | 183.0 | 79 | 310.5 | 217.4 | 39 | 359.6 | 251.8 | 99 | 408.8 | 286.2 | 59 | 457.9 | 320.6 |
| 20 | 262.1 | 183.5 | 80 | 311.3 | 217.9 | 40 | 360.4 | 252.4 | 500 | 409.6 | 286.8 | 60 | 458.7 | 321.2 |
| 321 | 263.0 | 184.1 | 381 | 312.1 | 218.5 | 441 | 361.3 | 252.9 | 501 | 410.4 | 287.4 | 561 | 459.6 | 321.8 |
| 22 | 263.8 | 184.7 | 82 | 312.9 | 219.1 | 42 | 362.1 | 253.5 | 02 | 411.2 | 287.9 | 62 | 460.4 | 322.3 |
| 23 | 264.6 | 185.2 | 83 | 313.7 | 219.7 | 43 | 362.9 | 254.1 | 03 | 412.1 | 288.5 | 63 | 461.2 | 322.9 |
| 24 | 265.4 | 185.8 | 84 | 314.6 | 220.2 | 44 | 363.7 | 254.7 | 04 | 412.9 | 289.1 | 64 | 462.0 | 323.5 |
| 25 | 266.2 | 186.4 | 85 | 315.4 | 220.8 | 45 | 364.5 | 255.2 | 05 | 413.7 | 289.7 | 65 | 462.8 | 324.1 |
| 26 | 267.1 | 187.0 | 86 | 316.2 | 221.4 | 46 | 365.4 | 255.8 | 06 | 414.5 | 290.2 | 66 | 463.7 | 324.6 |
| 27 | 267.9 | 187.5 | 87 | 317.0 | 222.0 | 47 | 366.2 | 256.4 | 07 | 415.3 | 290.8 | 67 | 464.5 | 325.2 |
| 28 | 268.7 | 188.1 | 88 | 317.8 | 222.5 | 48 | 367.0 | 256.9 | 08 | 416.1 | 291.4 | 68 | 465.3 | 325.8 |
| 29 | 269.5 | 188.7 | 89 | 318.7 | 223.1 | 49 | 367.8 | 257.5 | 09 | 417.0 | 291.9 | 69 | 466.1 | 326.4 |
| 30 | 270.3 | 189.3 | 90 | 319.5 | 223.7 | 50 | 368.6 | 258.1 | 10 | 417.8 | 292.5 | 70 | 466.9 | 326.9 |
| 331 | 271.1 | 189.8 | 391 | 320.3 | 224.3 | 451 | 369.4 | 258.7 | 511 | 418.6 | 293.1 | 571 | 467.8 | 327.5 |
| 32 | 272.0 | 190.4 | 92 | 321.1 | 224.8 | 52 | 370.3 | 259.2 | 12 | 419.4 | 293.7 | 72 | 468.6 | 328.1 |
| 33 | 272.8 | 191.0 | 93 | 321.9 | 225.4 | 53 | 371.1 | 259.8 | 13 | 420.2 | 294.2 | 73 | 469.4 | 328.7 |
| 34 | 273.6 | 191.6 | 94 | 322.8 | 226.0 | 54 | 371.9 | 260.4 | 14 | 421.1 | 294.8 | 74 | 470.2 | 329.2 |
| 35 | 274.4 | 192.1 | 95 | 323.6 | 226.5 | 55 | 372.7 | 261.0 | 15 | 421.9 | 295.4 | 75 | 471.0 | 329.8 |
| 36 | 275.2 | 192.7 | 96 | 324.4 | 227.1 | 56 | 373.5 | 261.5 | 16 | 422.7 | 296.0 | 76 | 471.9 | 330.4 |
| 37 | 276.1 | 193.3 | 97 | 325.2 | 227.7 | 57 | 374.4 | 262.1 | 17 | 423.5 | 296.5 | 77 | 472.7 | 331.0 |
| 38 | 276.9 | 193.9 | 98 | 326.0 | 228.3 | 58 | 375.2 | 262.7 | 18 | 424.3 | 297.1 | 78 | 473.5 | 331.5 |
| 39 | 277.7 | 194.4 | 99 | 326.9 | 228.8 | 59 | 376.0 | 263.3 | 19 | 425.2 | 297.7 | 79 | 474.3 | 332.1 |
| 40 | 278.5 | 195.0 | 400 | 327.7 | 229.4 | 60 | 376.8 | 263.8 | 20 | 426.0 | 298.3 | 80 | 475.1 | 332.7 |
| 341 | 279.3 | 195.6 | 401 | 328.5 | 230.0 | 461 | 377.6 | 264.4 | 521 | 426.8 | 298.8 | 581 | 476.0 | 333.3 |
| 42 | 280.2 | 196.1 | 02 | 329.3 | 230.6 | 62 | 378.5 | 265.0 | 22 | 427.6 | 299.4 | 82 | 476.8 | 333.8 |
| 43 | 281.0 | 196.7 | 03 | 330.1 | 231.1 | 63 | 379.3 | 265.5 | 23 | 428.4 | 300.0 | 83 | 477.6 | 334.4 |
| 44 | 281.8 | 197.3 | 04 | 330.9 | 231.7 | 64 | 380.1 | 266.1 | 24 | 429.3 | 300.5 | 84 | 478.4 | 335.0 |
| 45 | 282.6 | 197.9 | 05 | 331.8 | 232.3 | 65 | 380.9 | 266.7 | 25 | 430.1 | 301.1 | 85 | 479.2 | 335.6 |
| 46 | 283.4 | 198.4 | 06 | 332.6 | 232.9 | 66 | 381.7 | 267.3 | 26 | 430.9 | 301.7 | 86 | 480.1 | 336.1 |
| 47 | 284.3 | 199.0 | 07 | 333.4 | 233.4 | 67 | 382.6 | 267.8 | 27 | 431.7 | 302.3 | 87 | 480.9 | 336.7 |
| 48 | 285.1 | 199.6 | 08 | 334.2 | 234.0 | 68 | 383.4 | 268.4 | 28 | 432.5 | 302.8 | 88 | 481.7 | 337.3 |
| 49 | 285.9 | 200.2 | 09 | 335.0 | 234.6 | 69 | 384.2 | 269.0 | 29 | 433.4 | 303.4 | 89 | 482.5 | 337.9 |
| 50 | 286.7 | 200.7 | 10 | 335.9 | 235.1 | 70 | 385.0 | 269.6 | 30 | 434.2 | 304.0 | 90 | 483.3 | 338.4 |
| 351 | 287.5 | 201.3 | 411 | 336.7 | 235.7 | 471 | 385.8 | 270.1 | 531 | 435.0 | 304.5 | 591 | 484.2 | 339.0 |
| 52 | 288.3 | 201.9 | 12 | 337.5 | 236.3 | 72 | 386.6 | 270.7 | 32 | 435.8 | 305.1 | 92 | 485.0 | 339.6 |
| 53 | 289.2 | 202.5 | 13 | 338.3 | 236.9 | 73 | 387.5 | 271.3 | 33 | 436.6 | 305.7 | 93 | 485.8 | 340.2 |
| 54 | 290.0 | 203.0 | 14 | 339.1 | 237.4 | 74 | 388.3 | 271.9 | 34 | 437.5 | 306.3 | 94 | 486.6 | 340.7 |
| 55 | 290.8 | 203.6 | 15 | 340.0 | 238.0 | 75 | 389.1 | 272.4 | 35 | 438.3 | 306.8 | 95 | 487.4 | 341.3 |
| 56 | 291.6 | 204.2 | 16 | 340.8 | 238.6 | 76 | 389.9 | 273.0 | 36 | 439.1 | 307.4 | 96 | 488.3 | 341.9 |
| 57 | 292.4 | 204.7 | 17 | 341.6 | 239.2 | 77 | 390.7 | 273.6 | 37 | 439.9 | 308.0 | 97 | 489.1 | 342.5 |
| 58 | 293.3 | 205.3 | 18 | 342.4 | 239.7 | 78 | 391.6 | 274.2 | 38 | 440.7 | 308.6 | 98 | 489.9 | 343.0 |
| 59 | 294.1 | 205.9 | 19 | 343.2 | 240.3 | 79 | 392.4 | 274.7 | 39 | 441.5 | 309.1 | 99 | 490.7 | 343.6 |
| 60 | 294.9 | 206.5 | 20 | 344.1 | 240.9 | 80 | 393.2 | 275.3 | 40 | 442.3 | 309.7 | 600 | 491.5 | 344.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

55° (125°, 235°, 305°).

# TABLE 2.

Difference of Latitude and Departure for 36° (144°, 216°, 324°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 49.4 | 35.9 | 121 | 97.9 | 71.1 | 181 | 146.4 | 106.4 | 241 | 195.0 | 141.7 |
| 2 | 1.6 | 1.2 | 62 | 50.2 | 36.4 | 22 | 98.7 | 71.7 | 82 | 147.2 | 107.0 | 42 | 195.8 | 142.2 |
| 3 | 2.4 | 1.8 | 63 | 51.0 | 37.0 | 23 | 99.5 | 72.3 | 83 | 148.1 | 107.6 | 43 | 196.6 | 142.8 |
| 4 | 3.2 | 2.4 | 64 | 51.8 | 37.6 | 24 | 100.3 | 72.9 | 84 | 148.9 | 108.2 | 44 | 197.4 | 143.4 |
| 5 | 4.0 | 2.9 | 65 | 52.6 | 38.2 | 25 | 101.1 | 73.5 | 85 | 149.7 | 108.7 | 45 | 198.2 | 144.0 |
| 6 | 4.9 | 3.5 | 66 | 53.4 | 38.8 | 26 | 101.9 | 74.1 | 86 | 150.5 | 109.3 | 46 | 199.0 | 144.6 |
| 7 | 5.7 | 4.1 | 67 | 54.2 | 39.4 | 27 | 102.7 | 74.6 | 87 | 151.3 | 109.9 | 47 | 199.8 | 145.2 |
| 8 | 6.5 | 4.7 | 68 | 55.0 | 40.0 | 28 | 103.6 | 75.2 | 88 | 152.1 | 110.5 | 48 | 200.6 | 145.8 |
| 9 | 7.3 | 5.3 | 69 | 55.8 | 40.6 | 29 | 104.4 | 75.8 | 89 | 152.9 | 111.1 | 49 | 201.4 | 146.4 |
| 10 | 8.1 | 5.9 | 70 | 56.6 | 41.1 | 30 | 105.2 | 76.4 | 90 | 153.7 | 111.7 | 50 | 202.3 | 146.9 |
| 11 | 8.9 | 6.5 | 71 | 57.4 | 41.7 | 131 | 106.0 | 77.0 | 191 | 154.5 | 112.3 | 251 | 203.1 | 147.5 |
| 12 | 9.7 | 7.1 | 72 | 58.2 | 42.3 | 32 | 106.8 | 77.6 | 92 | 155.3 | 112.9 | 52 | 203.9 | 148.1 |
| 13 | 10.5 | 7.6 | 73 | 59.1 | 42.9 | 33 | 107.6 | 78.2 | 93 | 156.1 | 113.4 | 53 | 204.7 | 148.7 |
| 14 | 11.3 | 8.2 | 74 | 59.9 | 43.5 | 34 | 108.4 | 78.8 | 94 | 156.9 | 114.0 | 54 | 205.5 | 149.3 |
| 15 | 12.1 | 8.8 | 75 | 60.7 | 44.1 | 35 | 109.2 | 79.4 | 95 | 157.8 | 114.6 | 55 | 206.3 | 149.9 |
| 16 | 12.9 | 9.4 | 76 | 61.5 | 44.7 | 36 | 110.0 | 79.9 | 96 | 158.6 | 115.2 | 56 | 207.1 | 150.5 |
| 17 | 13.8 | 10.0 | 77 | 62.3 | 45.3 | 37 | 110.8 | 80.5 | 97 | 159.4 | 115.8 | 57 | 207.9 | 151.1 |
| 18 | 14.6 | 10.6 | 78 | 63.1 | 45.8 | 38 | 111.6 | 81.1 | 98 | 160.2 | 116.4 | 58 | 208.7 | 151.6 |
| 19 | 15.4 | 11.2 | 79 | 63.9 | 46.4 | 39 | 112.5 | 81.7 | 99 | 161.0 | 117.0 | 59 | 209.5 | 152.2 |
| 20 | 16.2 | 11.8 | 80 | 64.7 | 47.0 | 40 | 113.3 | 82.3 | 200 | 161.8 | 117.6 | 60 | 210.3 | 152.8 |
| 21 | 17.0 | 12.3 | 81 | 65.5 | 47.6 | 141 | 114.1 | 82.9 | 201 | 162.6 | 118.1 | 261 | 211.2 | 153.4 |
| 22 | 17.8 | 12.9 | 82 | 66.3 | 48.2 | 42 | 114.9 | 83.5 | 02 | 163.4 | 118.7 | 62 | 212.0 | 154.0 |
| 23 | 18.6 | 13.5 | 83 | 67.1 | 48.8 | 43 | 115.7 | 84.1 | 03 | 164.2 | 119.3 | 63 | 212.8 | 154.6 |
| 24 | 19.4 | 14.1 | 84 | 68.0 | 49.4 | 44 | 116.5 | 84.6 | 04 | 165.0 | 119.9 | 64 | 213.6 | 155.2 |
| 25 | 20.2 | 14.7 | 85 | 68.8 | 50.0 | 45 | 117.3 | 85.2 | 05 | 165.8 | 120.5 | 65 | 214.4 | 155.8 |
| 26 | 21.0 | 15.3 | 86 | 69.6 | 50.5 | 46 | 118.1 | 85.8 | 06 | 166.7 | 121.1 | 66 | 215.2 | 156.4 |
| 27 | 21.8 | 15.9 | 87 | 70.4 | 51.1 | 47 | 118.9 | 86.4 | 07 | 167.5 | 121.7 | 67 | 216.0 | 156.9 |
| 28 | 22.7 | 16.5 | 88 | 71.2 | 51.7 | 48 | 119.7 | 87.0 | 08 | 168.3 | 122.3 | 68 | 216.8 | 157.5 |
| 29 | 23.5 | 17.0 | 89 | 72.0 | 52.3 | 49 | 120.5 | 87.6 | 09 | 169.1 | 122.8 | 69 | 217.6 | 158.1 |
| 30 | 24.3 | 17.6 | 90 | 72.8 | 52.9 | 50 | 121.4 | 88.2 | 10 | 169.9 | 123.4 | 70 | 218.4 | 158.7 |
| 31 | 25.1 | 18.2 | 91 | 73.6 | 53.5 | 151 | 122.2 | 88.8 | 211 | 170.7 | 124.0 | 271 | 219.2 | 159.3 |
| 32 | 25.9 | 18.8 | 92 | 74.4 | 54.1 | 52 | 123.0 | 89.3 | 12 | 171.5 | 124.6 | 72 | 220.1 | 159.9 |
| 33 | 26.7 | 19.4 | 93 | 75.2 | 54.7 | 53 | 123.8 | 89.9 | 13 | 172.3 | 125.2 | 73 | 220.9 | 160.5 |
| 34 | 27.5 | 20.0 | 94 | 76.0 | 55.3 | 54 | 124.6 | 90.5 | 14 | 173.1 | 125.8 | 74 | 221.7 | 161.1 |
| 35 | 28.3 | 20.6 | 95 | 76.9 | 55.8 | 55 | 125.4 | 91.1 | 15 | 173.9 | 126.4 | 75 | 222.5 | 161.6 |
| 36 | 29.1 | 21.2 | 96 | 77.7 | 56.4 | 56 | 126.2 | 91.7 | 16 | 174.7 | 127.0 | 76 | 223.3 | 162.2 |
| 37 | 29.9 | 21.7 | 97 | 78.5 | 57.0 | 57 | 127.0 | 92.3 | 17 | 175.6 | 127.5 | 77 | 224.1 | 162.8 |
| 38 | 30.7 | 22.3 | 98 | 79.3 | 57.6 | 58 | 127.8 | 92.9 | 18 | 176.4 | 128.1 | 78 | 224.9 | 163.4 |
| 39 | 31.6 | 22.9 | 99 | 80.1 | 58.2 | 59 | 128.6 | 93.5 | 19 | 177.2 | 128.7 | 79 | 225.7 | 164.0 |
| 40 | 32.4 | 23.5 | 100 | 80.9 | 58.8 | 60 | 129.4 | 94.0 | 20 | 178.0 | 129.3 | 80 | 226.5 | 164.6 |
| 41 | 33.2 | 24.1 | 101 | 81.7 | 59.4 | 161 | 130.3 | 94.6 | 221 | 178.8 | 129.9 | 281 | 227.3 | 165.2 |
| 42 | 34.0 | 24.7 | 02 | 82.5 | 60.0 | 62 | 131.1 | 95.2 | 22 | 179.6 | 130.5 | 82 | 228.1 | 165.8 |
| 43 | 34.8 | 25.3 | 03 | 83.3 | 60.5 | 63 | 131.9 | 95.8 | 23 | 180.4 | 131.1 | 83 | 229.0 | 166.3 |
| 44 | 35.6 | 25.9 | 04 | 84.1 | 61.1 | 64 | 132.7 | 96.4 | 24 | 181 2 | 131.7 | 84 | 229.8 | 166.9 |
| 45 | 36.4 | 26.5 | 05 | 84.9 | 61.7 | 65 | 133.5 | 97.0 | 25 | 182.0 | 132.3 | 85 | 230.6 | 167.5 |
| 46 | 37.2 | 27.0 | 06 | 85.8 | 62.3 | 66 | 134.3 | 97.6 | 26 | 182.8 | 132.8 | 86 | 231.4 | 168.1 |
| 47 | 38.0 | 27.6 | 07 | 86.6 | 62.9 | 67 | 135.1 | 98.2 | 27 | 183.6 | 133.4 | 87 | 232.2 | 168.7 |
| 48 | 38.8 | 28.2 | 08 | 87.4 | 63.5 | 68 | 135.9 | 98.7 | 28 | 184.5 | 134.0 | 88 | 233.0 | 169.3 |
| 49 | 39.6 | 28.8 | 09 | 88.2 | 64.1 | 69 | 136.7 | 99.3 | 29 | 185.3 | 134.6 | 89 | 233.8 | 169.9 |
| 50 | 40.5 | 29.4 | 10 | 89.0 | 64.7 | 70 | 137.5 | 99.9 | 30 | 186.1 | 135.2 | 90 | 234.6 | 170.5 |
| 51 | 41.3 | 30.0 | 111 | 89.8 | 65.2 | 171 | 138.3 | 100.5 | 231 | 186.9 | 135.8 | 291 | 235.4 | 171.0 |
| 52 | 42.1 | 30.6 | 12 | 90.6 | 65.8 | 72 | 139.2 | 101.1 | 32 | 187.7 | 136.4 | 92 | 236.2 | 171.6 |
| 53 | 42.9 | 31.2 | 13 | 91.4 | 66.4 | 73 | 140.0 | 101.7 | 33 | 188.5 | 137.0 | 93 | 237.0 | 172.2 |
| 54 | 43.7 | 31.7 | 14 | 92.2 | 67.0 | 74 | 140.8 | 102.3 | 34 | 189.3 | 137.5 | 94 | 237.9 | 172.8 |
| 55 | 44.5 | 32.3 | 15 | 93.0 | 67.6 | 75 | 141.6 | 102.9 | 35 | 190.1 | 138.1 | 95 | 238.7 | 173.4 |
| 56 | 45.3 | 32.9 | 16 | 93.8 | 68.2 | 76 | 142.4 | 103.5 | 36 | 190.9 | 138.7 | 96 | 239.5 | 174.0 |
| 57 | 46.1 | 33.5 | 17 | 94.7 | 68.8 | 77 | 143.2 | 104.0 | 37 | 191.7 | 139.3 | 97 | 240.3 | 174.6 |
| 58 | 46.9 | 34.1 | 18 | 95.5 | 69.4 | 78 | 144.0 | 104.6 | 38 | 192.5 | 139.9 | 98 | 241.1 | 175.2 |
| 59 | 47.7 | 34.7 | 19 | 96.3 | 69.9 | 79 | 144.8 | 105.2 | 39 | 193.4 | 140.5 | 99 | 241.9 | 175.7 |
| 60 | 48.5 | 35.3 | 20 | 97.1 | 70.5 | 80 | 145.6 | 105.8 | 40 | 194.2 | 141.1 | 300 | 242.7 | 176.3 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

54° (126°, 234°, 306°).

TABLE 2. [Page 439

Difference of Latitude and Departure for 36° (144°, 216°, 324°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 243.5 | 176.9 | 361 | 292.1 | 212.2 | 421 | 340.6 | 247.5 | 481 | 389.1 | 282.7 | 541 | 437.7 | 318.0 |
| 02 | 244.3 | 177.5 | 62 | 292.9 | 212.8 | 22 | 341.4 | 248.1 | 82 | 390.0 | 283.3 | 42 | 438.5 | 318.6 |
| 03 | 245.1 | 178.1 | 63 | 293.7 | 213.4 | 23 | 342.2 | 248.6 | 83 | 390.8 | 283.9 | 43 | 439.3 | 319.1 |
| 04 | 246.0 | 178.7 | 64 | 294.5 | 214.0 | 24 | 343.0 | 249.2 | 84 | 391.6 | 284.5 | 44 | 440.2 | 319.7 |
| 05 | 246.8 | 179.3 | 65 | 295.3 | 214.6 | 25 | 343.8 | 249.8 | 85 | 392.4 | 285.1 | 45 | 441.0 | 320.3 |
| 06 | 247.6 | 179.9 | 66 | 296.1 | 215.1 | 26 | 344.7 | 250.4 | 86 | 393.2 | 285.6 | 46 | 441.8 | 320.9 |
| 07 | 248.4 | 180.5 | 67 | 296.9 | 215.7 | 27 | 345.5 | 251.0 | 87 | 394.0 | 286.2 | 47 | 442.6 | 321.5 |
| 08 | 249.2 | 181.1 | 68 | 297.7 | 216.3 | 28 | 346.3 | 251.6 | 88 | 394.8 | 286.8 | 48 | 443.4 | 322.1 |
| 09 | 250.0 | 181.6 | 69 | 298.5 | 216.9 | 29 | 347.1 | 252.2 | 89 | 395.6 | 287.4 | 49 | 444.2 | 322.7 |
| 10 | 250.8 | 182.2 | 70 | 299.3 | 217.5 | 30 | 347.9 | 252.8 | 90 | 396.4 | 288.0 | 50 | 445.0 | 323.3 |
| 311 | 251.6 | 182.8 | 371 | 300.2 | 218.1 | 431 | 348.7 | 253.3 | 491 | 397.3 | 288.6 | 551 | 445.8 | 323.8 |
| 12 | 252.4 | 183.4 | 72 | 301.0 | 218.7 | 32 | 349.5 | 253.9 | 92 | 398.1 | 289.2 | 52 | 446.6 | 324.4 |
| 13 | 253.2 | 184.0 | 73 | 301.8 | 219.3 | 33 | 350.3 | 254.5 | 93 | 398.9 | 289.8 | 53 | 447.4 | 325.0 |
| 14 | 254.0 | 184.6 | 74 | 302.6 | 219.8 | 34 | 351.1 | 255.1 | 94 | 399.7 | 290.3 | 54 | 448.2 | 325.6 |
| 15 | 254.9 | 185.2 | 75 | 303.4 | 220.4 | 35 | 351.9 | 255.7 | 95 | 400.5 | 290.9 | 55 | 449.0 | 326.2 |
| 16 | 255.7 | 185.8 | 76 | 304.2 | 221.0 | 36 | 352.7 | 256.3 | 96 | 401.3 | 291.5 | 56 | 449.8 | 326.8 |
| 17 | 256.5 | 186.4 | 77 | 305.0 | 221.6 | 37 | 353.6 | 256.9 | 97 | 402.1 | 292.1 | 57 | 450.7 | 327.4 |
| 18 | 257.3 | 186.9 | 78 | 305.8 | 222.2 | 38 | 354.4 | 257.5 | 98 | 402.9 | 292.7 | 58 | 451.5 | 328.0 |
| 19 | 258.1 | 187.5 | 79 | 306.6 | 222.8 | 39 | 355.2 | 258.0 | 99 | 403.7 | 293.3 | 59 | 452.3 | 328.5 |
| 20 | 258.9 | 188.1 | 80 | 307.4 | 223.4 | 40 | 356.0 | 258.6 | 500 | 404.5 | 293.9 | 60 | 453.1 | 329.1 |
| 321 | 259.7 | 188.7 | 381 | 308.2 | 224.0 | 441 | 356.8 | 259.2 | 501 | 405.3 | 294.5 | 561 | 453.9 | 329.7 |
| 22 | 260.5 | 189.3 | 82 | 309.1 | 224.5 | 42 | 357.6 | 259.8 | 02 | 406.1 | 295.0 | 62 | 454.7 | 330.3 |
| 23 | 261.3 | 189.9 | 83 | 309.9 | 225.1 | 43 | 358.4 | 260.4 | 03 | 407.0 | 295.6 | 63 | 455.5 | 330.9 |
| 24 | 262.1 | 190.5 | 84 | 310.7 | 225.7 | 44 | 359.2 | 261.0 | 04 | 407.8 | 296.2 | 64 | 456.3 | 331.5 |
| 25 | 262.9 | 191.0 | 85 | 311.5 | 226.3 | 45 | 360.0 | 261.6 | 05 | 408.6 | 296.8 | 65 | 457.1 | 332.1 |
| 26 | 263.7 | 191.6 | 86 | 312.3 | 226.9 | 46 | 360.8 | 262.2 | 06 | 409.4 | 297.4 | 66 | 457.9 | 332.7 |
| 27 | 264.6 | 192.2 | 87 | 313.1 | 227.5 | 47 | 361.6 | 262.8 | 07 | 410.2 | 298.0 | 67 | 458.7 | 333.3 |
| 28 | 265.4 | 192.8 | 88 | 313.9 | 228.1 | 48 | 362.4 | 263.3 | 08 | 411.0 | 298.6 | 68 | 459.5 | 333.8 |
| 29 | 266.2 | 193.4 | 89 | 314.7 | 228.7 | 49 | 363.3 | 263.9 | 09 | 411.8 | 299.2 | 69 | 460.3 | 334.4 |
| 30 | 267.0 | 194.0 | 90 | 315.5 | 229.2 | 50 | 364.1 | 264.5 | 10 | 412.6 | 299.8 | 70 | 461.1 | 335.0 |
| 331 | 267.8 | 194.6 | 391 | 316.3 | 229.8 | 451 | 364.9 | 265.1 | 511 | 413.4 | 300.3 | 571 | 462.0 | 335.6 |
| 32 | 268.6 | 195.2 | 92 | 317.1 | 230.4 | 52 | 365.7 | 265.7 | 12 | 414.2 | 300.9 | 72 | 462.8 | 336.2 |
| 33 | 269.4 | 195.7 | 93 | 318.0 | 231.0 | 53 | 366.5 | 266.3 | 13 | 415.1 | 301.5 | 73 | 463.6 | 336.8 |
| 34 | 270.2 | 196.3 | 94 | 318.8 | 231.6 | 54 | 367.3 | 266.9 | 14 | 415.9 | 302.1 | 74 | 464.4 | 337.4 |
| 35 | 271.0 | 196.9 | 95 | 319.6 | 232.2 | 55 | 368.1 | 267.5 | 15 | 416.7 | 302.7 | 75 | 465.2 | 338.0 |
| 36 | 271.8 | 197.5 | 96 | 320.4 | 232.8 | 56 | 368.9 | 268.0 | 16 | 417.5 | 303.3 | 76 | 466.0 | 338.5 |
| 37 | 272.6 | 198.1 | 97 | 321.2 | 233.4 | 57 | 369.7 | 268.6 | 17 | 418.3 | 303.9 | 77 | 466.8 | 339.1 |
| 38 | 273.5 | 198.7 | 98 | 322.0 | 233.9 | 58 | 370.5 | 269.2 | 18 | 419.1 | 304.4 | 78 | 467.6 | 339.7 |
| 39 | 274.3 | 199.3 | 99 | 322.8 | 234.5 | 59 | 371.3 | 269.8 | 19 | 419.9 | 305.0 | 79 | 468.4 | 340.3 |
| 40 | 275.1 | 199.9 | 400 | 323.6 | 235.1 | 60 | 372.2 | 270.4 | 20 | 420.7 | 305.6 | 80 | 469.3 | 340.9 |
| 341 | 275.9 | 200.4 | 401 | 324.4 | 235.7 | 461 | 373.0 | 271.0 | 521 | 421.5 | 306.2 | 581 | 470.1 | 341.5 |
| 42 | 276.7 | 201.0 | 02 | 325.2 | 236.3 | 62 | 373.8 | 271.6 | 22 | 422.3 | 306.8 | 82 | 470.9 | 342.1 |
| 43 | 277.5 | 201.6 | 03 | 326.0 | 236.9 | 63 | 374.6 | 272.2 | 23 | 423.1 | 307.4 | 83 | 471.7 | 342.7 |
| 44 | 278.3 | 202.2 | 04 | 326.9 | 237.5 | 64 | 375.4 | 272.7 | 24 | 423.9 | 308.0 | 84 | 472.5 | 343.2 |
| 45 | 279.1 | 202.8 | 05 | 327.7 | 238.1 | 65 | 376.2 | 273.3 | 25 | 424.7 | 308.6 | 85 | 473.3 | 343.8 |
| 46 | 279.9 | 203.4 | 06 | 328.5 | 238.7 | 66 | 377.0 | 273.9 | 26 | 425.5 | 309.2 | 86 | 474.1 | 344.4 |
| 47 | 280.7 | 204.0 | 07 | 329.3 | 239.2 | 67 | 377.8 | 274.5 | 27 | 426.4 | 309.7 | 87 | 474.9 | 345.0 |
| 48 | 281.5 | 204.6 | 08 | 330.1 | 239.8 | 68· | 378.6 | 275.1 | 28 | 427.2 | 310.3 | 88 | 475.7 | 345.6 |
| 49 | 282.4 | 205.1 | 09 | 330.9 | 240.4 | 69 | 379.4 | 275.7 | 29 | 428.0 | 310.9 | 89 | 476.5 | 346.2 |
| 50 | 283.2 | 205.7 | 10 | 331.7 | 241.0 | 70 | 380.2 | 276.3 | 30 | 428.8 | 311.5 | 90 | 477.3 | 346.8 |
| 351 | 284.0 | 206.3 | 411 | 332.5 | 241.6 | 471 | 381.1 | 276.9 | 531 | 429.6 | 312.1 | 591 | 478.2 | 347.4 |
| 52 | 284.8 | 206.9 | 12 | 333.3 | 242.2 | 72 | 381.9 | 277.4 | 32 | 430.4 | 312.7 | 92 | 479.0 | 347.9 |
| 53 | 285.6 | 207.5 | 13 | 334.1 | 242.8 | 73 | 382.7 | 278.0 | 33 | 431.2 | 313.3 | 93 | 479.8 | 348.5 |
| 54 | 286.4 | 208.1 | 14 | 334.9 | 243.4 | 74 | 383.5 | 278.6 | 34 | 432.0 | 313.9 | 94 | 480.6 | 349.1 |
| 55 | 287.2 | 208.7 | 15 | 335.8 | 243.9 | 75 | 384.3 | 279.2 | 35 | 432.9 | 314.4 | 95 | 481.4 | 349.7 |
| 56 | 288.0 | 209.3 | 16 | 336.6 | 244.5 | 76 | 385.1 | 279.8 | 36 | 433.7 | 315.0 | 96 | 482.2 | 350.3 |
| 57 | 288.8 | 209.8 | 17 | 337.4 | 245.1 | 77 | 385.9 | 280.4 | 37 | 434.5 | 315.6 | 97 | 483.0 | 350.9 |
| 58 | 289.6 | 210.4 | 18 | 338.2 | 245.7 | 78 | 386.7 | 281.0 | 38 | 435.3 | 316.2 | 98 | 483.8 | 351.5 |
| 59 | 290.4 | 211.0 | 19 | 339.0 | 246.3 | 79 | 387.5 | 281.6 | 39 | 436.1 | 316.8 | 99 | 484.6 | 352.1 |
| 60 | 291.3 | 211.6 | 20 | 339.8 | 246.9 | 80 | 388.3 | 282.1 | 40 | 436.9 | 317.4 | 600 | 485.4 | 352.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

54° (126°, 234°, 306°).

# TABLE 2.

Difference of Latitude and Departure for 37° (143°, 217°, 323°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 48.7 | 36.7 | 121 | 96.6 | 72.8 | 181 | 144.6 | 108.9 | 241 | 192.5 | 145.0 |
| 2 | 1.6 | 1.2 | 62 | 49.5 | 37.3 | 22 | 97.4 | 73.4 | 82 | 145.4 | 109.5 | 42 | 193.3 | 145.6 |
| 3 | 2.4 | 1.8 | 63 | 50.3 | 37.9 | 23 | 98.2 | 74.0 | 83 | 146.2 | 110.1 | 43 | 194.1 | 146.2 |
| 4 | 3.2 | 2.4 | 64 | 51.1 | 38.5 | 24 | 99.0 | 74.6 | 84 | 146.9 | 110.7 | 44 | 194.9 | 146.8 |
| 5 | 4.0 | 3.0 | 65 | 51.9 | 39.1 | 25 | 99.8 | 75.2 | 85 | 147.7 | 111.3 | 45 | 195.7 | 147.4 |
| 6 | 4.8 | 3.6 | 66 | 52.7 | 39.7 | 26 | 100.6 | 75.8 | 86 | 148.5 | 111.9 | 46 | 196.5 | 148.0 |
| 7 | 5.6 | 4.2 | 67 | 53.5 | 40.3 | 27 | 101.4 | 76.4 | 87 | 149.3 | 112.5 | 47 | 197.3 | 148.6 |
| 8 | 6.4 | 4.8 | 68 | 54.3 | 40.9 | 28 | 102.2 | 77.0 | 88 | 150.1 | 113.1 | 48 | 198.1 | 149.3 |
| 9 | 7.2 | 5.4 | 69 | 55.1 | 41.5 | 29 | 103.0 | 77.6 | 89 | 150.9 | 113.7 | 49 | 198.9 | 149.9 |
| 10 | 8.0 | 6.0 | 70 | 55.9 | 42.1 | 30 | 103.8 | 78.2 | 90 | 151.7 | 114.3 | 50 | 199.7 | 150.5 |
| 11 | 8.8 | 6.6 | 71 | 56.7 | 42.7 | 131 | 104.6 | 78.8 | 191 | 152.5 | 114.9 | 251 | 200.5 | 151.1 |
| 12 | 9.6 | 7.2 | 72 | 57.5 | 43.3 | 32 | 105.4 | 79.4 | 92 | 153.3 | 115.5 | 52 | 201.3 | 151.7 |
| 13 | 10.4 | 7.8 | 73 | 58.3 | 43.9 | 33 | 106.2 | 80.0 | 93 | 154.1 | 116.2 | 53 | 202.1 | 152.3 |
| 14 | 11.2 | 8.4 | 74 | 59.1 | 44.5 | 34 | 107.0 | 80.6 | 94 | 154.9 | 116.8 | 54 | 202.9 | 152.9 |
| 15 | 12.0 | 9.0 | 75 | 59.9 | 45.1 | 35 | 107.8 | 81.2 | 95 | 155.7 | 117.4 | 55 | 203.7 | 153.5 |
| 16 | 12.8 | 9.6 | 76 | 60.7 | 45.7 | 36 | 108.6 | 81.8 | 96 | 156.5 | 118.0 | 56 | 204.5 | 154.1 |
| 17 | 13.6 | 10.2 | 77 | 61.5 | 46.3 | 37 | 109.4 | 82.4 | 97 | 157.3 | 118.6 | 57 | 205.2 | 154.7 |
| 18 | 14.4 | 10.8 | 78 | 62.3 | 46.9 | 38 | 110.2 | 83.1 | 98 | 158.1 | 119.2 | 58 | 206.0 | 155.3 |
| 19 | 15.2 | 11.4 | 79 | 63.1 | 47.5 | 39 | 111.0 | 83.7 | 99 | 158.9 | 119.8 | 59 | 206.8 | 155.9 |
| 20 | 16.0 | 12.0 | 80 | 63.9 | 48.1 | 40 | 111.8 | 84.3 | 200 | 159.7 | 120.4 | 60 | 207.6 | 156.5 |
| 21 | 16.8 | 12.6 | 81 | 64.7 | 48.7 | 141 | 112.6 | 84.9 | 201 | 160.5 | 121.0 | 261 | 208.4 | 157.1 |
| 22 | 17.6 | 13.2 | 82 | 65.5 | 49.3 | 42 | 113.4 | 85.5 | 02 | 161.3 | 121.6 | 62 | 209.2 | 157.7 |
| 23 | 18.4 | 13.8 | 83 | 66.3 | 50.0 | 43 | 114.2 | 86.1 | 03 | 162.1 | 122.2 | 63 | 210.0 | 158.3 |
| 24 | 19.2 | 14.4 | 84 | 67.1 | 50.6 | 44 | 115.0 | 86.7 | 04 | 162.9 | 122.8 | 64 | 210.8 | 158.9 |
| 25 | 20.0 | 15.0 | 85 | 67.9 | 51.2 | 45 | 115.8 | 87.3 | 05 | 163.7 | 123.4 | 65 | 211.6 | 159.5 |
| 26 | 20.8 | 15.6 | 86 | 68.7 | 51.8 | 46 | 116.6 | 87.9 | 06 | 164.5 | 124.0 | 66 | 212.4 | 160.1 |
| 27 | 21.6 | 16.2 | 87 | 69.5 | 52.4 | 47 | 117.4 | 88.5 | 07 | 165.3 | 124.6 | 67 | 213.2 | 160.7 |
| 28 | 22.4 | 16.9 | 88 | 70.3 | 53.0 | 48 | 118.2 | 89.1 | 08 | 166.1 | 125.2 | 68 | 214.0 | 161.3 |
| 29 | 23.2 | 17.5 | 89 | 71.1 | 53.6 | 49 | 119.0 | 89.7 | 09 | 166.9 | 125.8 | 69 | 214.8 | 161.9 |
| 30 | 24.0 | 18.1 | 90 | 71.9 | 54.2 | 50 | 119.8 | 90.3 | 10 | 167.7 | 126.4 | 70 | 215.6 | 162.5 |
| 31 | 24.8 | 18.7 | 91 | 72.7 | 54.8 | 151 | 120.6 | 90.9 | 211 | 168.5 | 127.0 | 271 | 216.4 | 163.1 |
| 32 | 25.6 | 19.3 | 92 | 73.5 | 55.4 | 52 | 121.4 | 91.5 | 12 | 169.3 | 127.6 | 72 | 217.2 | 163.7 |
| 33 | 26.4 | 19.9 | 93 | 74.3 | 56.0 | 53 | 122.2 | 92.1 | 13 | 170.1 | 128.2 | 73 | 218.0 | 164.3 |
| 34 | 27.2 | 20.5 | 94 | 75.1 | 56.6 | 54 | 123.0 | 92.7 | 14 | 170.9 | 128.8 | 74 | 218.8 | 164.9 |
| 35 | 28.0 | 21.1 | 95 | 75.9 | 57.2 | 55 | 123.8 | 93.3 | 15 | 171.7 | 129.4 | 75 | 219.6 | 165.5 |
| 36 | 28.8 | 21.7 | 96 | 76.7 | 57.8 | 56 | 124.6 | 93.9 | 16 | 172.5 | 130.0 | 76 | 220.4 | 166.1 |
| 37 | 29.5 | 22.3 | 97 | 77.5 | 58.4 | 57 | 125.4 | 94.5 | 17 | 173.3 | 130.6 | 77 | 221.2 | 166.7 |
| 38 | 30.3 | 22.9 | 98 | 78.3 | 59.0 | 58 | 126.2 | 95.1 | 18 | 174.1 | 131.2 | 78 | 222.0 | 167.3 |
| 39 | 31.1 | 23.5 | 99 | 79.1 | 59.6 | 59 | 127.0 | 95.7 | 19 | 174.9 | 131.8 | 79 | 222.8 | 167.9 |
| 40 | 31.9 | 24.1 | 100 | 79.9 | 60.2 | 60 | 127.8 | 96.3 | 20 | 175.7 | 132.4 | 80 | 223.6 | 168.5 |
| 41 | 32.7 | 24.7 | 101 | 80.7 | 60.8 | 161 | 128.6 | 96.9 | 221 | 176.5 | 133.0 | 281 | 224.4 | 169.1 |
| 42 | 33.5 | 25.3 | 02 | 81.5 | 61.4 | 62 | 129.4 | 97.5 | 22 | 177.3 | 133.6 | 82 | 225.2 | 169.7 |
| 43 | 34.3 | 25.9 | 03 | 82.3 | 62.0 | 63 | 130.2 | 98.1 | 23 | 178.1 | 134.2 | 83 | 226.0 | 170.3 |
| 44 | 35.1 | 26.5 | 04 | 83.1 | 62.6 | 64 | 131.0 | 98.7 | 24 | 178.9 | 134.8 | 84 | 226.8 | 170.9 |
| 45 | 35.9 | 27.1 | 05 | 83.9 | 63.2 | 65 | 131.8 | 99.3 | 25 | 179.7 | 135.4 | 85 | 227.6 | 171.5 |
| 46 | 36.7 | 27.7 | 06 | 84.7 | 63.8 | 66 | 132.6 | 99.9 | 26 | 180.5 | 136.0 | 86 | 228.4 | 172.1 |
| 47 | 37.5 | 28.3 | 07 | 85.5 | 64.4 | 67 | 133.4 | 100.5 | 27 | 181.3 | 136.6 | 87 | 229.2 | 172.7 |
| 48 | 38.3 | 28.9 | 08 | 86.3 | 65.0 | 68 | 134.2 | 101.1 | 28 | 182.1 | 137.2 | 88 | 230.0 | 173.3 |
| 49 | 39.1 | 29.5 | 09 | 87.1 | 65.6 | 69 | 135.0 | 101.7 | 29 | 182.9 | 137.8 | 89 | 230.8 | 173.9 |
| 50 | 39.9 | 30.1 | 10 | 87.8 | 66.2 | 70 | 135.8 | 102.3 | 30 | 183.7 | 138.4 | 90 | 231.6 | 174.5 |
| 51 | 40.7 | 30.7 | 111 | 88.6 | 66.8 | 171 | 136.6 | 102.9 | 231 | 184.5 | 139.0 | 291 | 232.4 | 175.1 |
| 52 | 41.5 | 31.3 | 12 | 89.4 | 67.4 | 72 | 137.4 | 103.5 | 32 | 185.3 | 139.6 | 92 | 233.2 | 175.7 |
| 53 | 42.3 | 31.9 | 13 | 90.2 | 68.0 | 73 | 138.2 | 104.1 | 33 | 186.1 | 140.2 | 93 | 234.0 | 176.3 |
| 54 | 43.1 | 32.5 | 14 | 91.0 | 68.6 | 74 | 139.0 | 104.7 | 34 | 186.9 | 140.8 | 94 | 234.8 | 176.9 |
| 55 | 43.9 | 33.1 | 15 | 91.8 | 69.2 | 75 | 139.8 | 105.3 | 35 | 187.7 | 141.4 | 95 | 235.6 | 177.5 |
| 56 | 44.7 | 33.7 | 16 | 92.6 | 69.8 | 76 | 140.6 | 105.9 | 36 | 188.5 | 142.0 | 96 | 236.4 | 178.1 |
| 57 | 45.5 | 34.3 | 17 | 93.4 | 70.4 | 77 | 141.4 | 106.5 | 37 | 189.3 | 142.6 | 97 | 237.2 | 178.7 |
| 58 | 46.3 | 34.9 | 18 | 94.2 | 71.0 | 78 | 142.2 | 107.1 | 38 | 190.1 | 143.2 | 98 | 238.0 | 179.3 |
| 59 | 47.1 | 35.5 | 19 | 95.0 | 71.6 | 79 | 143.0 | 107.7 | 39 | 190.9 | 143.8 | 99 | 238.8 | 179.9 |
| 60 | 47.9 | 36.1 | 20 | 95.8 | 72.2 | 80 | 143.8 | 108.3 | 40 | 191.7 | 144.4 | 300 | 239.6 | 180.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

53° (127°, 233°, 307°).

TABLE 2. [Page 441

### Difference of Latitude and Departure for 37° (143°, 217°, 323°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 240.4 | 181.1 | 361 | 288.3 | 217.3 | 421 | 336.2 | 253.4 | 481 | 384.1 | 289.5 | 541 | 432.0 | 325.6 |
| 02 | 241.2 | 181.7 | 62 | 289.1 | 217.9 | 22 | 337.0 | 254.0 | 82 | 384.9 | 290.0 | 42 | 432.8 | 326.2 |
| 03 | 242.0 | 182.4 | 63 | 289.9 | 218.5 | 23 | 337.8 | 254.6 | 83 | 385.7 | 290.6 | 43 | 433.6 | 326.8 |
| 04 | 242.7 | 183.0 | 64 | 290.7 | 219.1 | 24 | 338.6 | 255.2 | 84 | 386.5 | 291.2 | 44 | 434.4 | 327.3 |
| 05 | 243.5 | 183.6 | 65 | 291.5 | 219.7 | 25 | 339.4 | 255.8 | 85 | 387.3 | 291.8 | 45 | 435.2 | 327.9 |
| 06 | 244.3 | 184.2 | 66 | 292.3 | 220.3 | 26 | 340.2 | 256.4 | 86 | 388.1 | 292.4 | 46 | 436.0 | 328.5 |
| 07 | 245.1 | 184.8 | 67 | 293.1 | 220.9 | 27 | 341.0 | 257.0 | 87 | 388.9 | 293.0 | 47 | 436.8 | 329.1 |
| 08 | 245.9 | 185.4 | 68 | 293.9 | 221.5 | 28 | 341.8 | 257.6 | 88 | 389.7 | 293.6 | 48 | 437.6 | 329.7 |
| 09 | 246.7 | 186.0 | 69 | 294.7 | 222.1 | 29 | 342.6 | 258.2 | 89 | 390.5 | 294.2 | 49 | 438.4 | 330.3 |
| 10 | 247.5 | 186.6 | 70 | 295.5 | 222.7 | 30 | 343.4 | 258.8 | 90 | 391.3 | 294.8 | 50 | 439.2 | 330.9 |
| 311 | 248.3 | 187.2 | 371 | 296.3 | 223.3 | 431 | 344.2 | 259.4 | 491 | 392.1 | 295.4 | 551 | 440.0 | 331.5 |
| 12 | 249.1 | 187.8 | 72 | 297.1 | 223.9 | 32 | 345.0 | 260.0 | 92 | 392.9 | 296.0 | 52 | 440.8 | 332.1 |
| 13 | 249.9 | 188.4 | 73 | 297.9 | 224.5 | 33 | 345.8 | 260.6 | 93 | 393.7 | 296.6 | 53 | 441.6 | 332.7 |
| 14 | 250.7 | 189.0 | 74 | 298.7 | 225.1 | 34 | 346.6 | 261.2 | 94 | 394.5 | 297.2 | 54 | 442.4 | 333.3 |
| 15 | 251.5 | 189.6 | 75 | 299.5 | 225.7 | 35 | 347.4 | 261.8 | 95 | 395.3 | 297.8 | 55 | 443.2 | 333.9 |
| 16 | 252.3 | 190.2 | 76 | 300.3 | 226.3 | 36 | 348.2 | 262.4 | 96 | 396.1 | 298.5 | 56 | 444.0 | 334.6 |
| 17 | 253.1 | 190.8 | 77 | 301.1 | 226.9 | 37 | 349.0 | 263.0 | 97 | 396.9 | 299.1 | 57 | 444.8 | 235.2 |
| 18 | 253.9 | 191.4 | 78 | 301.8 | 227.5 | 38 | 349.8 | 263.6 | 98 | 397.7 | 399.7 | 58 | 445.6 | 335.8 |
| 19 | 254.7 | 192.0 | 79 | 302.6 | 228.1 | 39 | 350.6 | 264.2 | 99 | 398.5 | 300.3 | 59 | 446.4 | 336.4 |
| 20 | 255.5 | 192.6 | 80 | 303.4 | 228.7 | 40 | 351.4 | 264.8 | 500 | 399.3 | 300.9 | 60 | 447.2 | 337.0 |
| 321 | 256.3 | 193.2 | 381 | 304.2 | 229.3 | 441 | 352.2 | 265.4 | 501 | 400.1 | 301.5 | 561 | 448.0 | 337.6 |
| 22 | 257.1 | 193.8 | 82 | 305.0 | 229.9 | 42 | 353.0 | 266.0 | 02 | 400.9 | 302.1 | 62 | 448.8 | 338.2 |
| 23 | 257.9 | 194.4 | 83 | 305.8 | 230.5 | 43 | 353.8 | 266.6 | 03 | 401.7 | 302.7 | 63 | 449.6 | 338.8 |
| 24 | 258.7 | 195.0 | 84 | 306.6 | 231.1 | 44 | 354.6 | 267.2 | 04 | 402.5 | 303.3 | 64 | 450.4 | 339.4 |
| 25 | 259.5 | 195.6 | 85 | 307.4 | 231.7 | 45 | 355.4 | 267.8 | 05 | 403.3 | 303.9 | 65 | 451.2 | 340.0 |
| 26 | 260.3 | 196.2 | 86 | 308.2 | 232.3 | 46 | 356.2 | 268.4 | 06 | 404.1 | 304.5 | 66 | 452.0 | 340.6 |
| 27 | 261.1 | 196.8 | 87 | 309.0 | 232.9 | 47 | 357.0 | 269.0 | 07 | 404.9 | 305.1 | 67 | 452.8 | 341.2 |
| 28 | 261.9 | 197.4 | 88 | 309.8 | 233.5 | 48 | 357.8 | 269.6 | 08 | 405.7 | 305.7 | 68 | 453.6 | 341.8 |
| 29 | 262.7 | 198.0 | 89 | 310.6 | 234.1 | 49 | 358.6 | 270.2 | 09 | 406.5 | 306.3 | 69 | 454.4 | 342.4 |
| 30 | 263.5 | 198.6 | 90 | 311.4 | 234.7 | 50 | 359.4 | 270.8 | 10 | 407.3 | 306.9 | 70 | 455.2 | 343.0 |
| 331 | 264.3 | 199.2 | 391 | 312.2 | 235.3 | 451 | 360.1 | 271.4 | 511 | 408.1 | 307.5 | 571 | 456.0 | 343.6 |
| 32 | 265.1 | 199.8 | 92 | 313.0 | 235.9 | 52 | 360.9 | 272.0 | 12 | 408.9 | 308.2 | 72 | 456.8 | 344.3 |
| 33 | 265.9 | 200.4 | 93 | 313.8 | 236.5 | 53 | 361.7 | 272.6 | 13 | 409.7 | 308.8 | 73 | 457.6 | 344.9 |
| 34 | 266.7 | 201.0 | 94 | 314.6 | 237.1 | 54 | 362.5 | 273.2 | 14 | 410.5 | 309.4 | 74 | 458.4 | 345.5 |
| 35 | 267.5 | 201.6 | 95 | 315.4 | 237.7 | 55 | 363.3 | 273.8 | 15 | 411.3 | 310.0 | 75 | 459.2 | 346.1 |
| 36 | 268.3 | 202.2 | 96 | 316.2 | 238.3 | 56 | 364.1 | 274.4 | 16 | 412.1 | 310.6 | 76 | 460.0 | 346.7 |
| 37 | 269.1 | 202.8 | 97 | 317.0 | 238.9 | 57 | 364.9 | 275.0 | 17 | 412.9 | 311.2 | 77 | 460.8 | 347.3 |
| 38 | 269.9 | 203.4 | 98 | 317.8 | 239.5 | 58 | 365.7 | 275.6 | 18 | 413.7 | 311.8 | 78 | 461.6 | 347.9 |
| 39 | 270.7 | 204.0 | 99 | 318.6 | 240.1 | 59 | 366.5 | 276.2 | 19 | 414.5 | 312.4 | 79 | 462.4 | 348.5 |
| 40 | 271.5 | 204.6 | 400 | 319.4 | 240.7 | 60 | 367.3 | 276.8 | 20 | 415.3 | 313.0 | 80 | 463.2 | 349.1 |
| 341 | 272.3 | 205.2 | 401 | 320.2 | 241.3 | 461 | 368.1 | 277.4 | 521 | 416.1 | 313.6 | 581 | 464.0 | 349.7 |
| 42 | 273.1 | 205.8 | 02 | 321.0 | 241.9 | 62 | 368.9 | 278.0 | 22 | 416.9 | 314.2 | 82 | 464.8 | 350.3 |
| 43 | 273.9 | 206.4 | 03 | 321.8 | 242.5 | 63 | 369.7 | 278.6 | 23 | 417.7 | 314.8 | 83 | 465.6 | 350.9 |
| 44 | 274.7 | 207.0 | 04 | 322.6 | 243.1 | 64 | 370.5 | 279.2 | 24 | 418.5 | 315.4 | 84 | 466.4 | 351.5 |
| 45 | 275.5 | 207.6 | 05 | 323.4 | 243.7 | 65 | 371.3 | 279.8 | 25 | 419.3 | 316.0 | 85 | 467.2 | 352.1 |
| 46 | 276.3 | 208.2 | 06 | 324.2 | 244.3 | 66 | 372.1 | 280.4 | 26 | 420.1 | 316.6 | 86 | 468.0 | 352.7 |
| 47 | 277.1 | 208.8 | 07 | 325.0 | 244.9 | 67 | 372.9 | 281.0 | 27 | 420.9 | 317.2 | 87 | 468.8 | 353.3 |
| 48 | 277.9 | 209.4 | 08 | 325.8 | 245.5 | 68 | 373.7 | 281.6 | 28 | 421.7 | 317.8 | 88 | 469.6 | 353.9 |
| 49 | 278.7 | 210.0 | 09 | 326.6 | 246.1 | 69 | 374.5 | 282.3 | 29 | 422.5 | 318.4 | 89 | 470.4 | 354.5 |
| 50 | 279.5 | 210.6 | 10 | 327.4 | 246.7 | 70 | 375.3 | 282.9 | 30 | 423.3 | 319.0 | 90 | 471.2 | 355.1 |
| 351 | 280.3 | 211.2 | 411 | 328.2 | 247.3 | 471 | 376.1 | 283.5 | 531 | 424.1 | 319.6 | 591 | 472.0 | 355.7 |
| 52 | 281.1 | 211.8 | 12 | 329.0 | 247.9 | 72 | 376.9 | 284.1 | 32 | 424.9 | 320.2 | 92 | 472.8 | 356.3 |
| 53 | 281.9 | 212.4 | 13 | 329.8 | 248.5 | 73 | 377.7 | 284.7 | 33 | 425.7 | 320.8 | 93 | 473.6 | 356.9 |
| 54 | 282.7 | 213.0 | 14 | 330.6 | 249.2 | 74 | 378.5 | 285.3 | 34 | 426.5 | 321.4 | 94 | 474.4 | 357.5 |
| 55 | 283.5 | 213.6 | 15 | 331.4 | 249.8 | 75 | 379.3 | 285.9 | 35 | 427.3 | 322.0 | 95 | 475.2 | 358.1 |
| 56 | 284.3 | 214.2 | 16 | 332.2 | 250.4 | 76 | 380.1 | 286.5 | 36 | 428.1 | 322.6 | 96 | 476.0 | 358.7 |
| 57 | 285.1 | 214.8 | 17 | 333.0 | 251.0 | 77 | 380.9 | 287.1 | 37 | 428.9 | 323.2 | 97 | 476.8 | 359.3 |
| 58 | 285.9 | 215.4 | 18 | 333.8 | 251.6 | 78 | 381.7 | 287.7 | 38 | 429.7 | 323.8 | 98 | 477.6 | 359.9 |
| 59 | 286.7 | 216.1 | 19 | 334.6 | 252.2 | 79 | 382.5 | 288.3 | 39 | 430.5 | 324.4 | 99 | 478.4 | 360.5 |
| 60 | 287.5 | 216.7 | 20 | 335.4 | 252.8 | 80 | 383.3 | 288.9 | 40 | 431.3 | 325.0 | 600 | 479.2 | 361.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

53° (127°, 233°, 307°).

# TABLE 2.

## Difference of Latitude and Departure for 38° (142°, 218°, 322°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 48.1 | 37.6 | 121 | 95.3 | 74.5 | 181 | 142.6 | 111.4 | 241 | 189.9 | 148.4 |
| 2 | 1.6 | 1.2 | 62 | 48.9 | 38.2 | 22 | 96.1 | 75.1 | 82 | 143.4 | 112.1 | 42 | 190.7 | 149.0 |
| 3 | 2.4 | 1.8 | 63 | 49.6 | 38.8 | 23 | 96.9 | 75.7 | 83 | 144.2 | 112.7 | 43 | 191.5 | 149.6 |
| 4 | 3.2 | 2.5 | 64 | 50.4 | 39.4 | 24 | 97.7 | 76.3 | 84 | 145.0 | 113.3 | 44 | 192.3 | 150.2 |
| 5 | 3.9 | 3.1 | 65 | 51.2 | 40.0 | 25 | 98.5 | 77.0 | 85 | 145.8 | 113.9 | 45 | 193.1 | 150.8 |
| 6 | 4.7 | 3.7 | 66 | 52.0 | 40.6 | 26 | 99.3 | 77.6 | 86 | 146.6 | 114.5 | 46 | 193.9 | 151.5 |
| 7 | 5.5 | 4.3 | 67 | 52.8 | 41.2 | 27 | 100.1 | 78.2 | 87 | 147.4 | 115.1 | 47 | 194.6 | 152.1 |
| 8 | 6.3 | 4.9 | 68 | 53.6 | 41.9 | 28 | 100.9 | 78.8 | 88 | 148.1 | 115.7 | 48 | 195.4 | 152.7 |
| 9 | 7.1 | 5.5 | 69 | 54.4 | 42.5 | 29 | 101.7 | 79.4 | 89 | 148.9 | 116.4 | 49 | 196.2 | 153.3 |
| 10 | 7.9 | 6.2 | 70 | 55.2 | 43.1 | 30 | 102.4 | 80.0 | 90 | 149.7 | 117.0 | 50 | 197.0 | 153.9 |
| 11 | 8.7 | 6.8 | 71 | 55.9 | 43.7 | 131 | 103.2 | 80.7 | 191 | 150.5 | 117.6 | 251 | 197.8 | 154.5 |
| 12 | 9.5 | 7.4 | 72 | 56.7 | 44.3 | 32 | 104.0 | 81.3 | 92 | 151.3 | 118.2 | 52 | 198.6 | 155.1 |
| 13 | 10.2 | 8.0 | 73 | 57.5 | 44.9 | 33 | 104.8 | 81.9 | 93 | 152.1 | 118.8 | 53 | 199.4 | 155.8 |
| 14 | 11.0 | 8.6 | 74 | 58.3 | 45.6 | 34 | 105.6 | 82.5 | 94 | 152.9 | 119.4 | 54 | 200.2 | 156.4 |
| 15 | 11.8 | 9.2 | 75 | 59.1 | 46.2 | 35 | 106.4 | 83.1 | 95 | 153.7 | 120.1 | 55 | 200.9 | 157.0 |
| 16 | 12.6 | 9.9 | 76 | 59.9 | 46.8 | 36 | 107.2 | 83.7 | 96 | 154.5 | 120.7 | 56 | 201.7 | 157.6 |
| 17 | 13.4 | 10.5 | 77 | 60.7 | 47.4 | 37 | 108.0 | 84.3 | 97 | 155.2 | 121.3 | 57 | 202.5 | 158.2 |
| 18 | 14.2 | 11.1 | 78 | 61.5 | 48.0 | 38 | 108.7 | 85.0 | 98 | 156.0 | 121.9 | 58 | 203.3 | 158.8 |
| 19 | 15.0 | 11.7 | 79 | 62.3 | 48.6 | 39 | 109.5 | 85.6 | 99 | 156.8 | 122.5 | 59 | 204.1 | 159.5 |
| 20 | 15.8 | 12.3 | 80 | 63.0 | 49.3 | 40 | 110.3 | 86.2 | 200 | 157.6 | 123.1 | 60 | 204.9 | 160.1 |
| 21 | 16.5 | 12.9 | 81 | 63.8 | 49.9 | 141 | 111.1 | 86.8 | 201 | 158.4 | 123.7 | 261 | 205.7 | 160.7 |
| 22 | 17.3 | 13.5 | 82 | 64.6 | 50.5 | 42 | 111.9 | 87.4 | 02 | 159.2 | 124.4 | 62 | 206.5 | 161.3 |
| 23 | 18.1 | 14.2 | 83 | 65.4 | 51.1 | 43 | 112.7 | 88.0 | 03 | 160.0 | 125.0 | 63 | 207.2 | 161.9 |
| 24 | 18.9 | 14.8 | 84 | 66.2 | 51.7 | 44 | 113.5 | 88.7 | 04 | 160.8 | 125.6 | 64 | 208.0 | 162.5 |
| 25 | 19.7 | 15.4 | 85 | 67.0 | 52.3 | 45 | 114.3 | 89.3 | 05 | 161.5 | 126.2 | 65 | 208.8 | 163.2 |
| 26 | 20.5 | 16.0 | 86 | 67.8 | 52.9 | 46 | 115.0 | 89.9 | 06 | 162.3 | 126.8 | 66 | 209.6 | 163.8 |
| 27 | 21.3 | 16.6 | 87 | 68.6 | 53.6 | 47 | 115.8 | 90.5 | 07 | 163.1 | 127.4 | 67 | 210.4 | 164.4 |
| 28 | 22.1 | 17.2 | 88 | 69.3 | 54.2 | 48 | 116.6 | 91.1 | 08 | 163.9 | 128.1 | 68 | 211.2 | 165.0 |
| 29 | 22.9 | 17.9 | 89 | 70.1 | 54.8 | 49 | 117.4 | 91.7 | 09 | 164.7 | 128.7 | 69 | 212.0 | 165.6 |
| 30 | 23.6 | 18.5 | 90 | 70.9 | 55.4 | 50 | 118.2 | 92.3 | 10 | 165.5 | 129.3 | 70 | 212.8 | 166.2 |
| 31 | 24.4 | 19.1 | 91 | 71.7 | 56.0 | 151 | 119.0 | 93.0 | 211 | 166.3 | 129.9 | 271 | 213.6 | 166.8 |
| 32 | 25.2 | 19.7 | 92 | 72.5 | 56.6 | 52 | 119.8 | 93.6 | 12 | 167.1 | 130.5 | 72 | 214.3 | 167.5 |
| 33 | 26.0 | 20.3 | 93 | 73.3 | 57.3 | 53 | 120.6 | 94.2 | 13 | 167.8 | 131.1 | 73 | 215.1 | 168.1 |
| 34 | 26.8 | 20.9 | 94 | 74.1 | 57.9 | 54 | 121.4 | 94.8 | 14 | 168.6 | 131.8 | 74 | 215.9 | 168.7 |
| 35 | 27.6 | 21.5 | 95 | 74.9 | 58.5 | 55 | 122.1 | 95.4 | 15 | 169.4 | 132.4 | 75 | 216.7 | 169.3 |
| 36 | 28.4 | 22.2 | 96 | 75.6 | 59.1 | 56 | 122.9 | 96.0 | 16 | 170.2 | 133.0 | 76 | 217.5 | 169.9 |
| 37 | 29.2 | 22.8 | 97 | 76.4 | 59.7 | 57 | 123.7 | 96.7 | 17 | 171.0 | 133.6 | 77 | 218.3 | 170.5 |
| 38 | 29.9 | 23.4 | 98 | 77.2 | 60.3 | 58 | 124.5 | 97.3 | 18 | 171.8 | 134.2 | 78 | 219.1 | 171.2 |
| 39 | 30.7 | 24.0 | 99 | 78.0 | 61.0 | 59 | 125.3 | 97.9 | 19 | 172.6 | 134.8 | 79 | 219.9 | 171.8 |
| 40 | 31.5 | 24.6 | 100 | 78.8 | 61.6 | 60 | 126.1 | 98.5 | 20 | 173.4 | 135.4 | 80 | 220.6 | 172.4 |
| 41 | 32.3 | 25.2 | 101 | 79.6 | 62.2 | 161 | 126.9 | 99.1 | 221 | 174.2 | 136.1 | 281 | 221.4 | 173.0 |
| 42 | 33.1 | 25.9 | 02 | 80.4 | 62.8 | 62 | 127.7 | 99.7 | 22 | 174.9 | 136.7 | 82 | 222.2 | 173.6 |
| 43 | 33.9 | 26.5 | 03 | 81.2 | 63.4 | 63 | 128.4 | 100.4 | 23 | 175.7 | 137.3 | 83 | 223.0 | 174.2 |
| 44 | 34.7 | 27.1 | 04 | 82.0 | 64.0 | 64 | 129.2 | 101.0 | 24 | 176.5 | 137.9 | 84 | 223.8 | 174.8 |
| 45 | 35.5 | 27.7 | 05 | 82.7 | 64.6 | 65 | 130.0 | 101.6 | 25 | 177.3 | 138.5 | 85 | 224.6 | 175.5 |
| 46 | 36.2 | 28.3 | 06 | 83.5 | 65.3 | 66 | 130.8 | 102.2 | 26 | 178.1 | 139.1 | 86 | 225.4 | 176.1 |
| 47 | 37.0 | 28.9 | 07 | 84.3 | 65.9 | 67 | 131.6 | 102.8 | 27 | 178.9 | 139.8 | 87 | 226.2 | 176.7 |
| 48 | 37.8 | 29.6 | 08 | 85.1 | 66.5 | 68 | 132.4 | 103.4 | 28 | 179.7 | 140.4 | 88 | 226.9 | 177.3 |
| 49 | 38.6 | 30.2 | 09 | 85.9 | 67.1 | 69 | 133.2 | 104.0 | 29 | 180.5 | 141.0 | 89 | 227.7 | 177.9 |
| 50 | 39.4 | 30.8 | 10 | 86.7 | 67.7 | 70 | 134.0 | 104.7 | 30 | 181.2 | 141.6 | 90 | 228.5 | 178.5 |
| 51 | 40.2 | 31.4 | 111 | 87.5 | 68.3 | 171 | 134.7 | 105.3 | 231 | 182.0 | 142.2 | 291 | 229.3 | 179.2 |
| 52 | 41.0 | 32.0 | 12 | 88.3 | 69.0 | 72 | 135.5 | 105.9 | 32 | 182.8 | 142.8 | 92 | 230.1 | 179.8 |
| 53 | 41.8 | 32.6 | 13 | 89.0 | 69.6 | 73 | 136.3 | 106.5 | 33 | 183.6 | 143.4 | 93 | 230.9 | 180.4 |
| 54 | 42.6 | 33.2 | 14 | 89.8 | 70.2 | 74 | 137.1 | 107.1 | 34 | 184.4 | 144.1 | 94 | 231.7 | 181.0 |
| 55 | 43.3 | 33.9 | 15 | 90.6 | 70.8 | 75 | 137.9 | 107.7 | 35 | 185.2 | 144.7 | 95 | 232.5 | 181.6 |
| 56 | 44.1 | 34.5 | 16 | 91.4 | 71.4 | 76 | 138.7 | 108.4 | 36 | 186.0 | 145.3 | 96 | 233.3 | 182.2 |
| 57 | 44.9 | 35.1 | 17 | 92.2 | 72.0 | 77 | 139.5 | 109.0 | 37 | 186.8 | 145.9 | 97 | 234.0 | 182.9 |
| 58 | 45.7 | 35.7 | 18 | 93.0 | 72.6 | 78 | 140.3 | 109.6 | 38 | 187.5 | 146.5 | 98 | 234.8 | 183.5 |
| 59 | 46.5 | 36.3 | 19 | 93.8 | 73.3 | 79 | 141.1 | 110.2 | 39 | 188.3 | 147.1 | 99 | 235.6 | 184.1 |
| 60 | 47.3 | 36.9 | 20 | 94.6 | 73.9 | 80 | 141.8 | 110.8 | 40 | 189.1 | 147.8 | 300 | 236.4 | 184.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

## 52° (128°, 232°, 308°).

TABLE 2. [Page 443

Difference of Latitude and Departure for 38° (142°, 218°, 322°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 237.2 | 185.3 | 361 | 284.5 | 222.3 | 421 | 331.8 | 259.2 | 481 | 379.0 | 296.2 | 541 | 426.3 | 333.1 |
| 02 | 238.0 | 185.9 | 62 | 285.3 | 222.9 | 22 | 332.5 | 259.8 | 82 | 379.8 | 296.8 | 42 | 427.1 | 333.7 |
| 03 | 238.8 | 186.6 | 63 | 286.0 | 223.5 | 23 | 333.3 | 260.4 | 83 | 380.6 | 297.4 | 43 | 427.9 | 334.3 |
| 04 | 239.6 | 187.2 | 64 | 286.8 | 224.1 | 24 | 334.1 | 261.0 | 84 | 381.4 | 298.0 | 44 | 428.7 | 335.0 |
| 05 | 240.3 | 187.8 | 65 | 287.6 | 224.7 | 25 | 334.9 | 261.7 | 85 | 382.2 | 298.6 | 45 | 429.5 | 335.6 |
| 06 | 241.1 | 188.4 | 66 | 288.4 | 225.3 | 26 | 335.7 | 262.3 | 86 | 383.0 | 299.2 | 46 | 430.3 | 336.2 |
| 07 | 241.9 | 189.0 | 67 | 289.2 | 226.0 | 27 | 336.5 | 262.9 | 87 | 383.8 | 299.8 | 47 | 431.0 | 336.8 |
| 08 | 242.7 | 189.6 | 68 | 290.0 | 226.6 | 28 | 337.3 | 263.5 | 88 | 384.5 | 300.4 | 48 | 431.8 | 337.4 |
| 09 | 243.5 | 190.2 | 69 | 290.8 | 227.2 | 29 | 338.1 | 264.1 | 89 | 385.3 | 301.1 | 49 | 432.6 | 338.0 |
| 10 | 244.3 | 190.9 | 70 | 291.6 | 227.8 | 30 | 338.8 | 264.7 | 90 | 386.1 | 301.7 | 50 | 433.4 | 338.6 |
| 311 | 245.1 | 191.5 | 371 | 292.4 | 228.4 | 431 | 339.6 | 265.4 | 491 | 386.9 | 302.3 | 551 | 434.2 | 339.3 |
| 12 | 245.9 | 192.1 | 72 | 293.1 | 229.0 | 32 | 340.4 | 266.0 | 92 | 387.7 | 302.9 | 52 | 435.0 | 339.9 |
| 13 | 246.6 | 192.7 | 73 | 293.9 | 229.6 | 33 | 341.2 | 266.6 | 93 | 388.5 | 303.5 | 53 | 435.8 | 340.5 |
| 14 | 247.4 | 193.3 | 74 | 294.7 | 230.3 | 34 | 342.0 | 267.2 | 94 | 389.3 | 304.2 | 54 | 436.6 | 341.1 |
| 15 | 248.2 | 193.9 | 75 | 295.5 | 230.9 | 35 | 342.8 | 267.8 | 95 | 390.1 | 304.8 | 55 | 437.4 | 341.7 |
| 16 | 249.0 | 194.6 | 76 | 296.3 | 231.5 | 36 | 343.6 | 268.4 | 96 | 390.9 | 305.4 | 56 | 438.1 | 342.3 |
| 17 | 249.8 | 195.2 | 77 | 297.1 | 232.1 | 37 | 344.4 | 269.1 | 97 | 391.6 | 306.0 | 57 | 438.9 | 343.0 |
| 18 | 250.6 | 195.8 | 78 | 297.9 | 232.7 | 38 | 345.2 | 269.7 | 98 | 392.4 | 306.6 | 58 | 439.7 | 343.6 |
| 19 | 251.4 | 196.4 | 79 | 298.7 | 233.3 | 39 | 345.9 | 270.3 | 99 | 393.2 | 307.2 | 59 | 440.5 | 344.2 |
| 20 | 252.2 | 197.0 | 80 | 299.4 | 234.0 | 40 | 346.7 | 270.9 | 500 | 394.0 | 307.8 | 60 | 441.3 | 344.8 |
| 321 | 253.0 | 197.6 | 381 | 300.2 | 234.6 | 441 | 347.5 | 271.5 | 501 | 394.8 | 308.4 | 561 | 442.1 | 345.4 |
| 22 | 253.7 | 198.2 | 82 | 301.0 | 235.2 | 42 | 348.3 | 272.1 | 02 | 395.6 | 309.1 | 62 | 442.9 | 346.0 |
| 23 | 254.5 | 198.9 | 83 | 301.8 | 235.8 | 43 | 349.1 | 272.7 | 03 | 396.4 | 309.7 | 63 | 443.7 | 346.6 |
| 24 | 255.3 | 199.5 | 84 | 302.6 | 236.4 | 44 | 349.9 | 273.4 | 04 | 397.2 | 310.3 | 64 | 444.4 | 347.2 |
| 25 | 256.1 | 200.1 | 85 | 303.4 | 237.0 | 45 | 350.7 | 274.0 | 05 | 397.9 | 310.9 | 65 | 445.2 | 347.8 |
| 26 | 256.9 | 200.7 | 86 | 304.2 | 237.7 | 46 | 351.5 | 274.6 | 06 | 398.7 | 311.6 | 66 | 446.0 | 348.5 |
| 27 | 257.7 | 201.3 | 87 | 305.0 | 238.3 | 47 | 352.2 | 275.2 | 07 | 399.5 | 312.2 | 67 | 446.8 | 349.1 |
| 28 | 258.5 | 201.9 | 88 | 305.7 | 238.9 | 48 | 353.0 | 275.8 | 08 | 400.3 | 312.8 | 68 | 447.6 | 349.7 |
| 29 | 259.3 | 202.6 | 89 | 306.5 | 239.5 | 49 | 353.8 | 276.4 | 09 | 401.1 | 313.4 | 69 | 448.4 | 350.3 |
| 30 | 260.0 | 203.2 | 90 | 307.3 | 240.1 | 50 | 354.6 | 277.1 | 10 | 401.9 | 314.0 | 70 | 449.2 | 350.9 |
| 331 | 260.8 | 203.8 | 391 | 308.1 | 240.7 | 451 | 355.4 | 277.7 | 511 | 402.7 | 314.6 | 571 | 450.0 | 351.6 |
| 32 | 261.6 | 204.4 | 92 | 308.9 | 241.3 | 52 | 356.2 | 278.3 | 12 | 403.5 | 315.2 | 72 | 450.7 | 352.2 |
| 33 | 262.4 | 205.0 | 93 | 309.7 | 242.0 | 53 | 357.0 | 278.9 | 13 | 404.2 | 315.8 | 73 | 451.5 | 352.8 |
| 34 | 263.2 | 205.6 | 94 | 310.5 | 242.6 | 54 | 357.8 | 279.5 | 14 | 405.0 | 316.4 | 74 | 452.3 | 353.4 |
| 35 | 264.0 | 206.3 | 95 | 311.3 | 243.2 | 55 | 358.5 | 280.1 | 15 | 405.8 | 317.1 | 75 | 453.1 | 354.0 |
| 36 | 264.8 | 206.9 | 96 | 312.1 | 243.8 | 56 | 359.3 | 280.7 | 16 | 406.6 | 317.7 | 76 | 453.9 | 354.6 |
| 37 | 265.6 | 207.5 | 97 | 312.8 | 244.4 | 57 | 360.1 | 281.4 | 17 | 407.4 | 318.3 | 77 | 454.7 | 355.2 |
| 38 | 266.3 | 208.1 | 98 | 313.6 | 245.0 | 58 | 360.9 | 282.0 | 18 | 408.2 | 318.9 | 78 | 455.5 | 355.8 |
| 39 | 267.1 | 208.7 | 99 | 314.4 | 245.7 | 59 | 361.7 | 282.6 | 19 | 409.0 | 319.5 | 79 | 456.3 | 356.4 |
| 40 | 267.9 | 209.3 | 400 | 315.2 | 246.3 | 60 | 362.5 | 283.2 | 20 | 409.8 | 320.2 | 80 | 457.1 | 357.1 |
| 341 | 268.7 | 209.9 | 401 | 316.0 | 246.9 | 461 | 363.3 | 283.8 | 521 | 410.6 | 320.8 | 581 | 457.8 | 357.7 |
| 42 | 269.5 | 210.6 | 02 | 316.8 | 247.5 | 62 | 364.1 | 284.4 | 22 | 411.3 | 321.4 | 82 | 458.6 | 358.3 |
| 43 | 270.3 | 211.2 | 03 | 317.6 | 248.1 | 63 | 364.9 | 285.1 | 23 | 412.1 | 322.0 | 83 | 459.4 | 358.9 |
| 44 | 271.1 | 211.8 | 04 | 318.4 | 248.7 | 64 | 365.6 | 285.7 | 24 | 412.9 | 322.6 | 84 | 460.2 | 359.5 |
| 45 | 271.9 | 212.4 | 05 | 319.1 | 249.3 | 65 | 366.4 | 286.3 | 25 | 413.7 | 323.2 | 85 | 461.0 | 360.2 |
| 46 | 272.7 | 213.0 | 06 | 319.9 | 250.0 | 66 | 367.2 | 286.9 | 26 | 414.5 | 323.8 | 86 | 461.8 | 360.8 |
| 47 | 273.4 | 213.6 | 07 | 320.7 | 250.6 | 67 | 368.0 | 287.5 | 27 | 415.3 | 324.5 | 87 | 462.6 | 361.4 |
| 48 | 274.2 | 214.3 | 08 | 321.5 | 251.2 | 68 | 368.8 | 288.1 | 28 | 416.1 | 325.1 | 88 | 463.3 | 362.0 |
| 49 | 275.0 | 214.9 | 09 | 322.3 | 251.8 | 69 | 369.6 | 288.7 | 29 | 416.9 | 325.7 | 89 | 464.1 | 362.6 |
| 50 | 275.8 | 215.5 | 10 | 323.1 | 252.4 | 70 | 370.4 | 289.3 | 30 | 417.6 | 326.3 | 90 | 464.9 | 363.2 |
| 351 | 276.6 | 216.1 | 411 | 323.9 | 253.0 | 471 | 371.2 | 290.0 | 531 | 418.4 | 326.9 | 591 | 465.7 | 363.8 |
| 52 | 277.4 | 216.7 | 12 | 324.7 | 253.7 | 72 | 371.9 | 290.6 | 32 | 419.2 | 327.5 | 92 | 466.5 | 364.4 |
| 53 | 278.2 | 217.3 | 13 | 325.5 | 254.3 | 73 | 372.7 | 291.2 | 33 | 420.0 | 328.2 | 93 | 467.3 | 365.1 |
| 54 | 279.0 | 218.0 | 14 | 326.2 | 254.9 | 74 | 373.5 | 291.8 | 34 | 420.8 | 328.8 | 94 | 468.1 | 365.7 |
| 55 | 279.7 | 218.6 | 15 | 327.0 | 255.5 | 75 | 374.3 | 292.4 | 35 | 421.6 | 329.4 | 95 | 468.9 | 366.3 |
| 56 | 280.5 | 219.2 | 16 | 327.8 | 256.1 | 76 | 375.1 | 293.1 | 36 | 422.4 | 330.0 | 96 | 469.7 | 366.9 |
| 57 | 281.3 | 219.8 | 17 | 328.6 | 256.7 | 77 | 375.9 | 293.7 | 37 | 423.2 | 330.6 | 97 | 470.5 | 367.5 |
| 58 | 282.1 | 220.4 | 18 | 329.4 | 257.4 | 78 | 376.7 | 294.3 | 38 | 424.0 | 331.2 | 98 | 471.2 | 368.1 |
| 59 | 282.9 | 221.0 | 19 | 330.2 | 258.0 | 79 | 377.5 | 294.9 | 39 | 424.7 | 331.8 | 99 | 472.0 | 368.7 |
| 60 | 283.7 | 221.6 | 20 | 331.0 | 258.6 | 80 | 378.2 | 295.5 | 40 | 425.5 | 332.5 | 600 | 472.8 | 369.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

52° (128°, 232°, 308°).

# TABLE 2.

Difference of Latitude and Departure for 39° (141°, 219°, 321°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 47.4 | 38.4 | 121 | 94.0 | 76.1 | 181 | 140.7 | 113.9 | 241 | 187.3 | 151.7 | | | |
| 2 | 1.6 | 1.3 | 62 | 48.2 | 39.0 | 22 | 94.8 | 76.8 | 82 | 141.4 | 114.5 | 42 | 188.1 | 152.3 | | | |
| 3 | 2.3 | 1.9 | 63 | 49.0 | 39.6 | 23 | 95.6 | 77.4 | 83 | 142.2 | 115.2 | 43 | 188.8 | 152.9 | | | |
| 4 | 3.1 | 2.5 | 64 | 49.7 | 40.3 | 24 | 96.4 | 78.0 | 84 | 143.0 | 115.8 | 44 | 189.6 | 153.6 | | | |
| 5 | 3.9 | 3.1 | 65 | 50.5 | 40.9 | 25 | 97.1 | 78.7 | 85 | 143.8 | 116.4 | 45 | 190.4 | 154.2 | | | |
| 6 | 4.7 | 3.8 | 66 | 51.3 | 41.5 | 26 | 97.9 | 79.3 | 86 | 144.5 | 117.1 | 46 | 191.2 | 154.8 | | | |
| 7 | 5.4 | 4.4 | 67 | 52.1 | 42.2 | 27 | 98.7 | 79.9 | 87 | 145.3 | 117.7 | 47 | 192.0 | 155.4 | | | |
| 8 | 6.2 | 5.0 | 68 | 52.8 | 42.8 | 28 | 99.5 | 80.6 | 88 | 146.1 | 118.3 | 48 | 192.7 | 156.1 | | | |
| 9 | 7.0 | 5.7 | 69 | 53.6 | 43.4 | 29 | 100.3 | 81.2 | 89 | 146.9 | 118.9 | 49 | 193.5 | 156.7 | | | |
| 10 | 7.8 | 6.3 | 70 | 54.4 | 44.1 | 30 | 101.0 | 81.8 | 90 | 147.7 | 119.6 | 50 | 194.3 | 157.3 | | | |
| 11 | 8.5 | 6.9 | 71 | 55.2 | 44.7 | 131 | 101.8 | 82.4 | 191 | 148.4 | 120.2 | 251 | 195.1 | 158.0 | | | |
| 12 | 9.3 | 7.6 | 72 | 56.0 | 45.3 | 32 | 102.6 | 83.1 | 92 | 149.2 | 120.8 | 52 | 195.8 | 158.6 | | | |
| 13 | 10.1 | 8.2 | 73 | 56.7 | 45.9 | 33 | 103.4 | 83.7 | 93 | 150.0 | 121.5 | 53 | 196.6 | 159.2 | | | |
| 14 | 10.9 | 8.8 | 74 | 57.5 | 46.6 | 34 | 104.1 | 84.3 | 94 | 150.8 | 122.1 | 54 | 197.4 | 159.8 | | | |
| 15 | 11.7 | 9.4 | 75 | 58.3 | 47.2 | 35 | 104.9 | 85.0 | 95 | 151.5 | 122.7 | 55 | 198.2 | 160.5 | | | |
| 16 | 12.4 | 10.1 | 76 | 59.1 | 47.8 | 36 | 105.7 | 85.6 | 96 | 152.3 | 123.3 | 56 | 198.9 | 161.1 | | | |
| 17 | 13.2 | 10.7 | 77 | 59.8 | 48.5 | 37 | 106.5 | 86.2 | 97 | 153.1 | 124.0 | 57 | 199.7 | 161.7 | | | |
| 18 | 14.0 | 11.3 | 78 | 60.6 | 49.1 | 38 | 107.2 | 86.8 | 98 | 153.9 | 124.6 | 58 | 200.5 | 162.4 | | | |
| 19 | 14.8 | 12.0 | 79 | 61.4 | 49.7 | 39 | 108.0 | 87.5 | 99 | 154.7 | 125.2 | 59 | 201.3 | 163.0 | | | |
| 20 | 15.5 | 12.6 | 80 | 62.2 | 50.3 | 40 | 108.8 | 88.1 | 200 | 155.4 | 125.9 | 60 | 202.1 | 163.6 | | | |
| 21 | 16.3 | 13.2 | 81 | 62.9 | 51.0 | 141 | 109.6 | 88.7 | 201 | 156.2 | 126.5 | 261 | 202.8 | 164.3 | | | |
| 22 | 17.1 | 13.8 | 82 | 63.7 | 51.6 | 42 | 110.4 | 89.4 | 02 | 157.0 | 127.1 | 62 | 203.6 | 164.9 | | | |
| 23 | 17.9 | 14.5 | 83 | 64.5 | 52.2 | 43 | 111.1 | 90.0 | 03 | 157.8 | 127.8 | 63 | 204.4 | 165.5 | | | |
| 24 | 18.7 | 15.1 | 84 | 65.3 | 52.9 | 44 | 111.9 | 90.6 | 04 | 158.5 | 128.4 | 64 | 205.2 | 166.1 | | | |
| 25 | 19.4 | 15.7 | 85 | 66.1 | 53.5 | 45 | 112.7 | 91.3 | 05 | 159.3 | 129.0 | 65 | 205.9 | 166.8 | | | |
| 26 | 20.2 | 16.4 | 86 | 66.8 | 54.1 | 46 | 113.5 | 91.9 | 06 | 160.1 | 129.6 | 66 | 206.7 | 167.4 | | | |
| 27 | 21.0 | 17.0 | 87 | 67.6 | 54.8 | 47 | 114.2 | 92.5 | 07 | 160.9 | 130.3 | 67 | 207.5 | 168.0 | | | |
| 28 | 21.8 | 17.6 | 88 | 68.4 | 55.4 | 48 | 115.0 | 93.1 | 08 | 161.6 | 130.9 | 68 | 208.3 | 168.7 | | | |
| 29 | 22.5 | 18.3 | 89 | 69.2 | 56.0 | 49 | 115.8 | 93.8 | 09 | 162.4 | 131.5 | 69 | 209.1 | 169.3 | | | |
| 30 | 23.3 | 18.9 | 90 | 69.9 | 56.6 | 50 | 116.6 | 94.4 | 10 | 163.2 | 132.2 | 70 | 209.8 | 169.9 | | | |
| 31 | 24.1 | 19.5 | 91 | 70.7 | 57.3 | 151 | 117.3 | 95.0 | 211 | 164.0 | 132.8 | 271 | 210.6 | 170.5 | | | |
| 32 | 24.9 | 20.1 | 92 | 71.5 | 57.9 | 52 | 118.1 | 95.7 | 12 | 164.8 | 133.4 | 72 | 211.4 | 171.2 | | | |
| 33 | 25.6 | 20.8 | 93 | 72.3 | 58.5 | 53 | 118.9 | 96.3 | 13 | 165.5 | 134.0 | 73 | 212.2 | 171.8 | | | |
| 34 | 26.4 | 21.4 | 94 | 73.1 | 59.2 | 54 | 119.7 | 96.9 | 14 | 166.3 | 134.7 | 74 | 212.9 | 172.4 | | | |
| 35 | 27.2 | 22.0 | 95 | 73.8 | 59.8 | 55 | 120.5 | 97.5 | 15 | 167.1 | 135.3 | 75 | 213.7 | 173.1 | | | |
| 36 | 28.0 | 22.7 | 96 | 74.6 | 60.4 | 56 | 121.2 | 98.2 | 16 | 167.9 | 135.9 | 76 | 214.5 | 173.7 | | | |
| 37 | 28.8 | 23.3 | 97 | 75.4 | 61.0 | 57 | 122.0 | 98.8 | 17 | 168.6 | 136.6 | 77 | 215.3 | 174.3 | | | |
| 38 | 29.5 | 23.9 | 98 | 76.2 | 61.7 | 58 | 122.8 | 99.4 | 18 | 169.4 | 137.2 | 78 | 216.0 | 175.0 | | | |
| 39 | 30.3 | 24.5 | 99 | 76.9 | 62.3 | 59 | 123.6 | 100.1 | 19 | 170.2 | 137.8 | 79 | 216.8 | 175.6 | | | |
| 40 | 31.1 | 25.2 | 100 | 77.7 | 62.9 | 60 | 124.3 | 100.7 | 20 | 171.0 | 138.5 | 80 | 217.6 | 176.2 | | | |
| 41 | 31.9 | 25.8 | 101 | 78.5 | 63.6 | 161 | 125.1 | 101.3 | 221 | 171.7 | 139.1 | 281 | 218.4 | 176.8 | | | |
| 42 | 32.6 | 26.4 | 02 | 79.3 | 64.2 | 62 | 125.9 | 101.9 | 22 | 172.5 | 139.7 | 82 | 219.2 | 177.5 | | | |
| 43 | 33.4 | 27.1 | 03 | 80.0 | 64.8 | 63 | 126.7 | 102.6 | 23 | 173.3 | 140.3 | 83 | 219.9 | 178.1 | | | |
| 44 | 34.2 | 27.7 | 04 | 80.8 | 65.4 | 64 | 127.5 | 103.2 | 24 | 174.1 | 141.0 | 84 | 220.7 | 178.7 | | | |
| 45 | 35.0 | 28.3 | 05 | 81.6 | 66.1 | 65 | 128.2 | 103.8 | 25 | 174.9 | 141.6 | 85 | 221.5 | 179.4 | | | |
| 46 | 35.7 | 28.9 | 06 | 82.4 | 66.7 | 66 | 129.0 | 104.5 | 26 | 175.6 | 142.2 | 86 | 222.3 | 180.0 | | | |
| 47 | 36.5 | 29.6 | 07 | 83.2 | 67.3 | 67 | 129.8 | 105.1 | 27 | 176.4 | 142.9 | 87 | 223.0 | 180.6 | | | |
| 48 | 37.3 | 30.2 | 08 | 83.9 | 68.0 | 68 | 130.6 | 105.7 | 28 | 177.2 | 143.5 | 88 | 223.8 | 181.2 | | | |
| 49 | 38.1 | 30.8 | 09 | 84.7 | 68.6 | 69 | 131.3 | 106.4 | 29 | 178.0 | 144.1 | 89 | 224.6 | 181.9 | | | |
| 50 | 38.9 | 31.5 | 10 | 85.5 | 69.2 | 70 | 132.1 | 107.0 | 30 | 178.7 | 144.7 | 90 | 225.4 | 182.5 | | | |
| 51 | 39.6 | 32.1 | 111 | 86.3 | 69.9 | 171 | 132.9 | 107.6 | 231 | 179.5 | 145.4 | 291 | 226.1 | 183.1 | | | |
| 52 | 40.4 | 32.7 | 12 | 87.0 | 70.5 | 72 | 133.7 | 108.2 | 32 | 180.3 | 146.0 | 92 | 226.9 | 183.8 | | | |
| 53 | 41.2 | 33.4 | 13 | 87.8 | 71.1 | 73 | 134.4 | 108.9 | 33 | 181.1 | 146.6 | 93 | 227.7 | 184.4 | | | |
| 54 | 42.0 | 34.0 | 14 | 88.6 | 71.7 | 74 | 135.2 | 109.5 | 34 | 181.9 | 147.3 | 94 | 228.5 | 185.0 | | | |
| 55 | 42.7 | 34.6 | 15 | 89.4 | 72.4 | 75 | 136.0 | 110.1 | 35 | 182.6 | 147.9 | 95 | 229.3 | 185.6 | | | |
| 56 | 43.5 | 35.2 | 16 | 90.1 | 73.0 | 76 | 136.8 | 110.8 | 36 | 183.4 | 148.5 | 96 | 230.0 | 186.3 | | | |
| 57 | 44.3 | 35.9 | 17 | 90.9 | 73.6 | 77 | 137.6 | 111.4 | 37 | 184.2 | 149.1 | 97 | 230.8 | 186.9 | | | |
| 58 | 45.1 | 36.5 | 18 | 91.7 | 74.3 | 78 | 138.3 | 112.0 | 38 | 185.0 | 149.8 | 98 | 231.6 | 187.5 | | | |
| 59 | 45.9 | 37.1 | 19 | 92.5 | 74.9 | 79 | 139.1 | 112.6 | 39 | 185.7 | 150.4 | 99 | 232.4 | 188.2 | | | |
| 60 | 46.6 | 37.8 | 20 | 93.3 | 75.5 | 80 | 139.9 | 113.3 | 40 | 186.5 | 151.0 | 300 | 233.1 | 188.8 | | | |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

51° (129°, 231°, 309°).

# TABLE 2. [Page 445

Difference of Latitude and Departure for 39° (141°, 219°, 321°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 233.9 | 189.4 | 361 | 280.6 | 227.1 | 421 | 327.2 | 264.9 | 481 | 373.8 | 302.6 | 541 | 420.4 | 340.4 |
| 02 | 234.7 | 190.0 | 62 | 281.3 | 227.8 | 22 | 328.0 | 265.5 | 82 | 374.6 | 303.3 | 42 | 421.2 | 341.0 |
| 03 | 235.5 | 190.6 | 63 | 282.1 | 228.4 | 23 | 328.7 | 266.2 | 83 | 375.4 | 303.9 | 43 | 422.0 | 341.7 |
| 04 | 236.3 | 191.3 | 64 | 282.9 | 229.0 | 24 | 329.5 | 266.8 | 84 | 376.1 | 304.5 | 44 | 422.7 | 342.3 |
| 05 | 237.0 | 191.9 | 65 | 283.7 | 229.7 | 25 | 330.3 | 267.4 | 85 | 376.9 | 305.2 | 45 | 423.5 | 342.9 |
| 06 | 237.8 | 192.5 | 66 | 284.4 | 230.3 | 26 | 331.1 | 268.0 | 86 | 377.7 | 305.8 | 46 | 424.3 | 343.6 |
| 07 | 238.6 | 193.2 | 67 | 285.2 | 230.9 | 27 | 331.9 | 268.7 | 87 | 378.5 | 306.4 | 47 | 425.1 | 344.2 |
| 08 | 239.4 | 193.8 | 68 | 286.0 | 231.5 | 28 | 332.6 | 269.3 | 88 | 379.3 | 307.1 | 48 | 425.9 | 344.8 |
| 09 | 240.1 | 194.4 | 69 | 286.8 | 232.2 | 29 | 333.4 | 269.9 | 89 | 380.0 | 307.7 | 49 | 426.6 | 345.5 |
| 10 | 240.9 | 195.0 | 70 | 287.6 | 232.8 | 30 | 334.2 | 270.6 | 90 | 380.8 | 308.3 | 50 | 427.4 | 346.1 |
| 311 | 241.7 | 195.7 | 371 | 288.3 | 233.4 | 431 | 335.0 | 271.2 | 491 | 381.6 | 308.9 | 551 | 428.2 | 346.7 |
| 12 | 242.5 | 196.3 | 72 | 289.1 | 234.1 | 32 | 335.7 | 271.8 | 92 | 382.4 | 309.6 | 52 | 429.0 | 347.4 |
| 13 | 243.3 | 196.9 | 73 | 289.9 | 234.7 | 33 | 336.5 | 272.5 | 93 | 383.1 | 310.2 | 53 | 429.7 | 348.0 |
| 14 | 244.0 | 197.6 | 74 | 290.7 | 235.3 | 34 | 337.3 | 273.1 | 94 | 383.9 | 310.8 | 54 | 430.5 | 348.6 |
| 15 | 244.8 | 198.2 | 75 | 291.4 | 236.0 | 35 | 338.1 | 273.7 | 95 | 384.7 | 311.5 | 55 | 431.3 | 349.2 |
| 16 | 245.6 | 198.8 | 76 | 292.2 | 236.6 | 36 | 338.8 | 274.3 | 96 | 385.5 | 312.1 | 56 | 432.1 | 349.9 |
| 17 | 246.4 | 199.5 | 77 | 293.0 | 237.2 | 37 | 339.6 | 275.0 | 97 | 386.2 | 312.7 | 57 | 432.8 | 350.5 |
| 18 | 247.1 | 200.1 | 78 | 293.8 | 237.8 | 38 | 340.4 | 275.6 | 98 | 387.0 | 313.3 | 58 | 433.6 | 351.1 |
| 19 | 247.9 | 200.7 | 79 | 294.5 | 238.5 | 39 | 341.2 | 276.2 | 99 | 387.8 | 314.0 | 59 | 434.4 | 351.7 |
| 20 | 248.7 | 201.3 | 80 | 295.3 | 239.1 | 40 | 342.0 | 276.9 | 500 | 388.6 | 314.7 | 60 | 435.2 | 352.4 |
| 321 | 249.5 | 202.0 | 381 | 296.1 | 239.7 | 441 | 342.7 | 277.5 | 501 | 389.4 | 315.3 | 561 | 435.9 | 353.0 |
| 22 | 250.3 | 202.6 | 82 | 296.9 | 240.4 | 42 | 343.5 | 278.1 | 02 | 390.1 | 315.9 | 62 | 436.7 | 353.6 |
| 23 | 251.0 | 203.2 | 83 | 297.7 | 241.0 | 43 | 344.3 | 278.7 | 03 | 390.9 | 316.5 | 63 | 437.5 | 354.3 |
| 24 | 251.8 | 203.9 | 84 | 298.4 | 241.6 | 44 | 345.1 | 279.4 | 04 | 391.7 | 317.1 | 64 | 438.3 | 354.9 |
| 25 | 252.6 | 204.5 | 85 | 299.2 | 242.2 | 45 | 345.8 | 280.0 | 05 | 392.5 | 317.8 | 65 | 439.1 | 355.5 |
| 26 | 253.4 | 205.1 | 86 | 300.0 | 242.9 | 46 | 346.6 | 280.6 | 06 | 393.2 | 318.4 | 66 | 439.8 | 356.2 |
| 27 | 254.1 | 205.7 | 87 | 300.8 | 243.5 | 47 | 347.4 | 281.3 | 07 | 394.0 | 319.0 | 67 | 440.6 | 356.8 |
| 28 | 254.9 | 206.4 | 88 | 301.5 | 244.1 | 48 | 348.2 | 281.9 | 08 | 394.8 | 319.6 | 68 | 441.4 | 357.4 |
| 29 | 255.7 | 207.0 | 89 | 302.3 | 244.8 | 49 | 349.0 | 282.5 | 09 | 395.6 | 320.3 | 69 | 442.2 | 358.1 |
| 30 | 256.5 | 207.6 | 90 | 303.1 | 245.4 | 50 | 349.7 | 283.2 | 10 | 396.3 | 320.9 | 70 | 443.0 | 358.7 |
| 331 | 257.2 | 208.3 | 391 | 303.9 | 246.0 | 451 | 350.5 | 283.8 | 511 | 397.1 | 321.6 | 571 | 443.7 | 359.3 |
| 32 | 258.0 | 208.9 | 92 | 304.7 | 246.7 | 52 | 351.3 | 284.4 | 12 | 397.9 | 322.2 | 72 | 444.5 | 359.9 |
| 33 | 258.8 | 209.5 | 93 | 305.4 | 247.3 | 53 | 352.1 | 285.0 | 13 | 398.7 | 322.8 | 73 | 445.3 | 360.6 |
| 34 | 259.6 | 210.2 | 94 | 306.2 | 247.9 | 54 | 352.8 | 285.7 | 14 | 399.4 | 323.4 | 74 | 446.1 | 361.2 |
| 35 | 260.4 | 210.8 | 95 | 307.0 | 248.5 | 55 | 353.6 | 286.3 | 15 | 400.2 | 324.1 | 75 | 446.9 | 361.8 |
| 36 | 261.1 | 211.4 | 96 | 307.8 | 249.2 | 56 | 354.4 | 286.9 | 16 | 401.0 | 324.7 | 76 | 447.6 | 362.4 |
| 37 | 261.9 | 212.0 | 97 | 308.5 | 249.8 | 57 | 355.2 | 287.6 | 17 | 401.8 | 325.3 | 77 | 448.4 | 363.1 |
| 38 | 262.7 | 212.7 | 98 | 309.3 | 250.4 | 58 | 355.9 | 288.2 | 18 | 402.5 | 325.9 | 78 | 449.2 | 363.7 |
| 39 | 263.5 | 213.3 | 99 | 310.1 | 251.1 | 59 | 356.7 | 288.8 | 19 | 403.3 | 326.6 | 79 | 450.0 | 364.3 |
| 40 | 264.2 | 213.9 | 400 | 310.9 | 251.7 | 60 | 357.5 | 289.4 | 20 | 404.1 | 327.2 | 80 | 450.7 | 365.0 |
| 341 | 265.0 | 214.6 | 401 | 311.6 | 252.3 | 461 | 358.3 | 290.1 | 521 | 404.9 | 327.8 | 581 | 451.5 | 365.6 |
| 42 | 265.8 | 215.2 | 02 | 312.4 | 252.9 | 62 | 359.1 | 290.7 | 22 | 405.7 | 328.5 | 82 | 452.3 | 366.2 |
| 43 | 266.6 | 215.8 | 03 | 313.2 | 253.6 | 63 | 359.8 | 291.3 | 23 | 406.4 | 329.1 | 83 | 453.1 | 366.9 |
| 44 | 267.3 | 216.4 | 04 | 314.0 | 254.2 | 64 | 360.6 | 292.0 | 24 | 407.2 | 329.7 | 84 | 453.9 | 367.5 |
| 45 | 268.1 | 217.1 | 05 | 314.8 | 254.8 | 65 | 361.4 | 292.6 | 25 | 408.0 | 330.4 | 85 | 454.6 | 368.1 |
| 46 | 268.9 | 217.7 | 06 | 315.5 | 255.5 | 66 | 362.2 | 293.2 | 26 | 408.8 | 331.0 | 86 | 455.4 | 368.8 |
| 47 | 269.7 | 218.3 | 07 | 316.3 | 256.1 | 67 | 362.9 | 293.8 | 27 | 409.5 | 331.6 | 87 | 456.2 | 369.4 |
| 48 | 270.5 | 219.0 | 08 | 317.1 | 256.7 | 68 | 363.7 | 294.5 | 28 | 410.3 | 332.3 | 88 | 457.0 | 370.0 |
| 49 | 271.2 | 219.6 | 09 | 317.9 | 257.3 | 69 | 364.5 | 295.1 | 29 | 411.1 | 332.9 | 89 | 457.8 | 370.6 |
| 50 | 272.0 | 220.2 | 10 | 318.6 | 258.0 | 70 | 365.3 | 295.7 | 30 | 411.9 | 333.5 | 90 | 458.5 | 371.3 |
| 351 | 272.8 | 220.8 | 411 | 319.4 | 258.6 | 471 | 366.0 | 296.4 | 531 | 412.6 | 334.1 | 591 | 459.3 | 371.9 |
| 52 | 273.6 | 221.5 | 12 | 320.2 | 259.2 | 72 | 366.8 | 297.0 | 32 | 413.4 | 334.8 | 92 | 460.1 | 372.5 |
| 53 | 274.3 | 222.1 | 13 | 321.0 | 259.9 | 73 | 367.6 | 297.6 | 33 | 414.2 | 335.4 | 93 | 460.9 | 373.2 |
| 54 | 275.1 | 222.7 | 14 | 321.8 | 260.5 | 74 | 368.4 | 298.3 | 34 | 415.0 | 336.1 | 94 | 461.6 | 373.8 |
| 55 | 275.9 | 223.4 | 15 | 322.5 | 261.1 | 75 | 369.2 | 298.9 | 35 | 415.8 | 336.7 | 95 | 462.4 | 374.4 |
| 56 | 276.7 | 224.0 | 16 | 323.3 | 261.8 | 76 | 369.9 | 299.5 | 36 | 416.5 | 337.3 | 96 | 463.2 | 375.1 |
| 57 | 277.5 | 224.6 | 17 | 324.1 | 262.4 | 77 | 370.7 | 300.1 | 37 | 417.3 | 337.9 | 97 | 464.0 | 375.7 |
| 58 | 278.2 | 225.3 | 18 | 324.9 | 263.0 | 78 | 371.5 | 300.8 | 38 | 418.1 | 338.5 | 98 | 464.8 | 376.3 |
| 59 | 279.0 | 225.9 | 19 | 325.6 | 263.6 | 79 | 372.3 | 301.4 | 39 | 418.9 | 339.1 | 99 | 465.5 | 376.9 |
| 60 | 279.8 | 226.5 | 20 | 326.4 | 264.3 | 80 | 373.0 | 302.0 | 40 | 419.6 | 339.8 | 600 | 466.3 | 377.6 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

# TABLE 2.

Difference of Latitude and Departure for 40° (140°, 220°, 320°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.6 | 61 | 46.7 | 39.2 | 121 | 92.7 | 77.8 | 181 | 138.7 | 116.3 | 241 | 184.6 | 154.9 |
| 2 | 1.5 | 1.3 | 62 | 47.5 | 39.9 | 22 | 93.5 | 78.4 | 82 | 139.4 | 117.0 | 42 | 185.4 | 155.6 |
| 3 | 2.3 | 1.9 | 63 | 48.3 | 40.5 | 23 | 94.2 | 79.1 | 83 | 140.2 | 117.6 | 43 | 186.1 | 156.2 |
| 4 | 3.1 | 2.6 | 64 | 49.0 | 41.1 | 24 | 95.0 | 79.7 | 84 | 141.0 | 118.3 | 44 | 186.9 | 156.8 |
| 5 | 3.8 | 3.2 | 65 | 49.8 | 41.8 | 25 | 95.8 | 80.3 | 85 | 141.7 | 118.9 | 45 | 187.7 | 157.5 |
| 6 | 4.6 | 3.9 | 66 | 50.6 | 42.4 | 26 | 96.5 | 81.0 | 86 | 142.5 | 119.6 | 46 | 188.4 | 158.1 |
| 7 | 5.4 | 4.5 | 67 | 51.3 | 43.1 | 27 | 97.3 | 81.6 | 87 | 143.3 | 120.2 | 47 | 189.2 | 158.8 |
| 8 | 6.1 | 5.1 | 68 | 52.1 | 43.7 | 28 | 98.1 | 82.3 | 88 | 144.0 | 120.8 | 48 | 190.0 | 159.4 |
| 9 | 6.9 | 5.8 | 69 | 52.9 | 44.4 | 29 | 98.8 | 82.9 | 89 | 144.8 | 121.5 | 49 | 190.7 | 160.1 |
| 10 | 7.7 | 6.4 | 70 | 53.6 | 45.0 | 30 | 99.6 | 83.6 | 90 | 145.5 | 122.1 | 50 | 191.5 | 160.7 |
| 11 | 8.4 | 7.1 | 71 | 54.4 | 45.6 | 131 | 100.4 | 84.2 | 191 | 146.3 | 122.8 | 251 | 192.3 | 161.3 |
| 12 | 9.2 | 7.7 | 72 | 55.2 | 46.3 | 32 | 101.1 | 84.8 | 92 | 147.1 | 123.4 | 52 | 193.0 | 162.0 |
| 13 | 10.0 | 8.4 | 73 | 55.9 | 46.9 | 33 | 101.9 | 85.5 | 93 | 147.8 | 124.1 | 53 | 193.8 | 162.6 |
| 14 | 10.7 | 9.0 | 74 | 56.7 | 47.6 | 34 | 102.6 | 86.1 | 94 | 148.6 | 124.7 | 54 | 194.6 | 163.3 |
| 15 | 11.5 | 9.6 | 75 | 57.5 | 48.2 | 35 | 103.4 | 86.8 | 95 | 149.4 | 125.3 | 55 | 195.3 | 163.9 |
| 16 | 12.3 | 10.3 | 76 | 58.2 | 48.9 | 36 | 104.2 | 87.4 | 96 | 150.1 | 126.0 | 56 | 196.1 | 164.6 |
| 17 | 13.0 | 10.9 | 77 | 59.0 | 49.5 | 37 | 104.9 | 88.1 | 97 | 150.9 | 126.6 | 57 | 196.9 | 165.2 |
| 18 | 13.8 | 11.6 | 78 | 59.8 | 50.1 | 38 | 105.7 | 88.7 | 98 | 151.7 | 127.3 | 58 | 197.6 | 165.8 |
| 19 | 14.6 | 12.2 | 79 | 60.5 | 50.8 | 39 | 106.5 | 89.3 | 99 | 152.4 | 127.9 | 59 | 198.4 | 166.5 |
| 20 | 15.3 | 12.9 | 80 | 61.3 | 51.4 | 40 | 107.2 | 90.0 | 200 | 153.2 | 128.6 | 60 | 199.2 | 167.1 |
| 21 | 16.1 | 13.5 | 81 | 62.0 | 52.1 | 141 | 108.0 | 90.6 | 201 | 154.0 | 129.2 | 261 | 199.9 | 167.8 |
| 22 | 16.9 | 14.1 | 82 | 62.8 | 52.7 | 42 | 108.8 | 91.3 | 02 | 154.7 | 129.8 | 62 | 200.7 | 168.4 |
| 23 | 17.6 | 14.8 | 83 | 63.6 | 53.4 | 43 | 109.5 | 91.9 | 03 | 155.5 | 130.5 | 63 | 201.5 | 169.1 |
| 24 | 18.4 | 15.4 | 84 | 64.3 | 54.0 | 44 | 110.3 | 92.6 | 04 | 156.3 | 131.1 | 64 | 202.2 | 169.7 |
| 25 | 19.2 | 16.1 | 85 | 65.1 | 54.6 | 45 | 111.1 | 93.2 | 05 | 157.0 | 131.8 | 65 | 203.0 | 170.3 |
| 26 | 19.9 | 16.7 | 86 | 65.9 | 55.3 | 46 | 111.8 | 93.8 | 06 | 157.8 | 132.4 | 66 | 203.8 | 171.0 |
| 27 | 20.7 | 17.4 | 87 | 66.6 | 55.9 | 47 | 112.6 | 94.5 | 07 | 158.6 | 133.1 | 67 | 204.5 | 171.6 |
| 28 | 21.4 | 18.0 | 88 | 67.4 | 56.6 | 48 | 113.4 | 95.1 | 08 | 159.3 | 133.7 | 68 | 205.3 | 172.3 |
| 29 | 22.2 | 18.6 | 89 | 68.2 | 57.2 | 49 | 114.1 | 95.8 | 09 | 160.1 | 134.3 | 69 | 206.1 | 172.9 |
| 30 | 23.0 | 19.3 | 90 | 68.9 | 57.9 | 50 | 114.9 | 96.4 | 10 | 160.9 | 135.0 | 70 | 206.8 | 173.6 |
| 31 | 23.7 | 19.9 | 91 | 69.7 | 58.5 | 151 | 115.7 | 97.1 | 211 | 161.6 | 135.6 | 271 | 207.6 | 174.2 |
| 32 | 24.5 | 20.6 | 92 | 70.5 | 59.1 | 52 | 116.4 | 97.7 | 12 | 162.4 | 136.3 | 72 | 208.4 | 174.8 |
| 33 | 25.3 | 21.2 | 93 | 71.2 | 59.8 | 53 | 117.2 | 98.3 | 13 | 163.2 | 136.9 | 73 | 209.1 | 175.5 |
| 34 | 26.0 | 21.9 | 94 | 72.0 | 60.4 | 54 | 118.0 | 99.0 | 14 | 163.9 | 137.6 | 74 | 209.9 | 176.1 |
| 35 | 26.8 | 22.5 | 95 | 72.8 | 61.1 | 55 | 118.7 | 99.6 | 15 | 164.7 | 138.2 | 75 | 210.7 | 176.8 |
| 36 | 27.6 | 23.1 | 96 | 73.5 | 61.7 | 56 | 119.5 | 100.3 | 16 | 165.5 | 138.8 | 76 | 211.4 | 177.4 |
| 37 | 28.3 | 23.8 | 97 | 74.3 | 62.4 | 57 | 120.3 | 100.9 | 17 | 166.2 | 139.5 | 77 | 212.2 | 178.1 |
| 38 | 29.1 | 24.4 | 98 | 75.1 | 63.0 | 58 | 121.0 | 101.6 | 18 | 167.0 | 140.1 | 78 | 213.0 | 178.7 |
| 39 | 29.9 | 25.1 | 99 | 75.8 | 63.6 | 59 | 121.8 | 102.2 | 19 | 167.8 | 140.8 | 79 | 213.7 | 179.3 |
| 40 | 30.6 | 25.7 | 100 | 76.6 | 64.3 | 60 | 122.6 | 102.8 | 20 | 168.5 | 141.4 | 80 | 214.5 | 180.0 |
| 41 | 31.4 | 26.4 | 101 | 77.4 | 64.9 | 161 | 123.3 | 103.5 | 221 | 169.3 | 142.1 | 281 | 215.3 | 180.6 |
| 42 | 32.2 | 27.0 | 02 | 78.1 | 65.6 | 62 | 124.1 | 104.1 | 22 | 170.1 | 142.7 | 82 | 216.0 | 181.3 |
| 43 | 32.9 | 27.6 | 03 | 78.9 | 66.2 | 63 | 124.9 | 104.8 | 23 | 170.8 | 143.3 | 83 | 216.8 | 181.9 |
| 44 | 33.7 | 28.3 | 04 | 79.7 | 66.8 | 64 | 125.6 | 105.4 | 24 | 171.6 | 144.0 | 84 | 217.6 | 182.6 |
| 45 | 34.5 | 28.9 | 05 | 80.4 | 67.5 | 65 | 126.4 | 106.1 | 25 | 172.4 | 144.6 | 85 | 218.3 | 183.2 |
| 46 | 35.2 | 29.6 | 06 | 81.2 | 68.1 | 66 | 127.2 | 106.7 | 26 | 173.1 | 145.3 | 86 | 219.1 | 183.8 |
| 47 | 36.0 | 30.2 | 07 | 82.0 | 68.8 | 67 | 127.9 | 107.3 | 27 | 173.9 | 145.9 | 87 | 219.9 | 184.5 |
| 48 | 36.8 | 30.9 | 08 | 82.7 | 69.4 | 68 | 128.7 | 108.0 | 28 | 174.7 | 146.6 | 88 | 220.6 | 185.1 |
| 49 | 37.5 | 31.5 | 09 | 83.5 | 70.1 | 69 | 129.5 | 108.6 | 29 | 175.4 | 147.2 | 89 | 221.4 | 185.8 |
| 50 | 38.3 | 32.1 | 10 | 84.3 | 70.7 | 70 | 130.2 | 109.3 | 30 | 176.2 | 147.8 | 90 | 222.2 | 186.4 |
| 51 | 39.1 | 32.8 | 111 | 85.0 | 71.3 | 171 | 131.0 | 109.9 | 231 | 177.0 | 148.5 | 291 | 222.9 | 187.1 |
| 52 | 39.8 | 33.4 | 12 | 85.8 | 72.0 | 72 | 131.8 | 110.6 | 32 | 177.7 | 149.1 | 92 | 223.7 | 187.7 |
| 53 | 40.6 | 34.1 | 13 | 86.6 | 72.6 | 73 | 132.5 | 111.2 | 33 | 178.5 | 149.8 | 93 | 224.5 | 188.3 |
| 54 | 41.4 | 34.7 | 14 | 87.3 | 73.3 | 74 | 133.3 | 111.8 | 34 | 179.3 | 150.4 | 94 | 225.2 | 189.0 |
| 55 | 42.1 | 35.4 | 15 | 88.1 | 73.9 | 75 | 134.1 | 112.5 | 35 | 180.0 | 151.1 | 95 | 226.0 | 189.6 |
| 56 | 42.9 | 36.0 | 16 | 88.9 | 74.6 | 76 | 134.8 | 113.1 | 36 | 180.8 | 151.7 | 96 | 226.7 | 190.3 |
| 57 | 43.7 | 36.6 | 17 | 89.6 | 75.2 | 77 | 135.6 | 113.8 | 37 | 181.6 | 152.3 | 97 | 227.5 | 190.9 |
| 58 | 44.4 | 37.3 | 18 | 90.4 | 75.8 | 78 | 136.4 | 114.4 | 38 | 182.3 | 153.0 | 98 | 228.3 | 191.6 |
| 59 | 45.2 | 37.9 | 19 | 91.2 | 76.5 | 79 | 137.1 | 115.1 | 39 | 183.1 | 153.6 | 99 | 229.0 | 192.2 |
| 60 | 46.0 | 38.6 | 20 | 91.9 | 77.1 | 80 | 137.9 | 115.7 | 40 | 183.9 | 154.3 | 300 | 229.8 | 192.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

50° (130°, 230°, 310°).

TABLE 2. [Page 447

Difference of Latitude and Departure for 40° (140°, 220°, 320°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 230.6 | 193.5 | 361 | 276.5 | 232.1 | 421 | 322.5 | 270.6 | 481 | 368.5 | 309.2 | 541 | 414.4 | 347.7 |
| 02 | 231.3 | 194.1 | 62 | 277.3 | 232.7 | 22 | 323.3 | 271.3 | 82 | 369.2 | 309.8 | 42 | 415.2 | 348.4 |
| 03 | 232.1 | 194.8 | 63 | 278.1 | 233.3 | 23 | 324.0 | 271.9 | 83 | 370.0 | 310.5 | 43 | 416.0 | 349.0 |
| 04 | 232.9 | 195.4 | 64 | 278.8 | 234.0 | 24 | 324.8 | 272.6 | 84 | 370.8 | 311.1 | 44 | 416.7 | 349.7 |
| 05 | 233.6 | 196.1 | 65 | 279.6 | 234.6 | 25 | 325.6 | 273.2 | 85 | 371.5 | 311.7 | 45 | 417.5 | 350.3 |
| 06 | 234.4 | 196.7 | 66 | 280.4 | 235.3 | 26 | 326.3 | 273.8 | 86 | 372.3 | 312.4 | 46 | 418.3 | 351.0 |
| 07 | 235.2 | 197.3 | 67 | 281.1 | 235.9 | 27 | 327.1 | 274.5 | 87 | 373.1 | 313.0 | 47 | 419.0 | 351.6 |
| 08 | 235.9 | 198.0 | 68 | 281.9 | 236.6 | 28 | 327.9 | 275.1 | 88 | 373.8 | 313.6 | 48 | 419.8 | 352.2 |
| 09 | 236.7 | 198.6 | 69 | 282.7 | 237.2 | 29 | 328.6 | 275.8 | 89 | 374.6 | 314.3 | 49 | 420.6 | 352.9 |
| 10 | 237.5 | 199.3 | 70 | 283.4 | 237.8 | 30 | 329.4 | 276.4 | 90 | 375.4 | 314.9 | 50 | 421.3 | 353.5 |
| 311 | 238.2 | 199.9 | 371 | 284.2 | 238.5 | 431 | 330.2 | 277.1 | 491 | 376.1 | 315.6 | 551 | 422.1 | 354.2 |
| 12 | 239.0 | 200.6 | 72 | 285.0 | 239.1 | 32 | 330.9 | 277.7 | 92 | 376.9 | 316.2 | 52 | 422.9 | 354.8 |
| 13 | 239.8 | 201.2 | 73 | 285.7 | 239.7 | 33 | 331.7 | 278.3 | 93 | 377.7 | 316.9 | 53 | 423.6 | 355.5 |
| 14 | 240.5 | 201.8 | 74 | 286.5 | 240.4 | 34 | 332.5 | 279.0 | 94 | 378.4 | 317.5 | 54 | 424.4 | 356.1 |
| 15 | 241.3 | 202.5 | 75 | 287.3 | 241.0 | 35 | 333.2 | 279.6 | 95 | 379.2 | 318.2 | 55 | 425.2 | 356.8 |
| 16 | 242.1 | 203.1 | 76 | 288.0 | 241.7 | 36 | 334.0 | 280.3 | 96 | 380.0 | 318.8 | 56 | 425.9 | 357.4 |
| 17 | 242.8 | 203.8 | 77 | 288.8 | 242.3 | 37 | 334.8 | 280.9 | 97 | 380.7 | 319.5 | 57 | 426.7 | 358.0 |
| 18 | 243.6 | 204.4 | 78 | 289.6 | 243.0 | 38 | 335.5 | 281.6 | 98 | 381.5 | 320.1 | 58 | 427.5 | 358.7 |
| 19 | 244.4 | 205.1 | 79 | 290.3 | 243.6 | 39 | 336.3 | 282.2 | 99 | 382.3 | 320.8 | 59 | 428.2 | 359.3 |
| 20 | 245.1 | 205.7 | 80 | 291.1 | 244.3 | 40 | 337.1 | 282.8 | 500 | 383.0 | 321.4 | 60 | 429.0 | 360.0 |
| 321 | 245.9 | 206.3 | 381 | 291.9 | 244.9 | 441 | 337.8 | 283.5 | 501 | 383.8 | 322.0 | 561 | 429.8 | 360.6 |
| 22 | 246.7 | 207.0 | 82 | 292.6 | 245.6 | 42 | 338.6 | 284.1 | 02 | 384.6 | 322.7 | 62 | 430.5 | 361.2 |
| 23 | 247.4 | 207.6 | 83 | 293.4 | 246.2 | 43 | 339.4 | 284.8 | 03 | 385.3 | 323.3 | 63 | 431.3 | 361.9 |
| 24 | 248.2 | 208.3 | 84 | 294.2 | 246.8 | 44 | 340.1 | 285.4 | 04 | 386.1 | 324.0 | 64 | 432.1 | 362.5 |
| 25 | 249.0 | 208.9 | 85 | 294.9 | 247.5 | 45 | 340.9 | 286.0 | 05 | 386.8 | 324.6 | 65 | 432.8 | 363.2 |
| 26 | 249.7 | 209.6 | 86 | 295.7 | 248.1 | 46 | 341.7 | 286.7 | 06 | 387.6 | 325.2 | 66 | 433.6 | 363.8 |
| 27 | 250.5 | 210.2 | 87 | 296.5 | 248.8 | 47 | 342.4 | 287.3 | 07 | 388.4 | 325.9 | 67 | 434.3 | 364.5 |
| 28 | 251.3 | 210.8 | 88 | 297.2 | 249.4 | 48 | 343.2 | 288.0 | 08 | 389.2 | 326.5 | 68 | 435.1 | 365.1 |
| 29 | 252.0 | 211.5 | 89 | 298.0 | 250.1 | 49 | 344.0 | 288.6 | 09 | 389.9 | 327.1 | 69 | 435.9 | 365.8 |
| 30 | 252.8 | 212.1 | 90 | 298.8 | 250.7 | 50 | 344.7 | 289.3 | 10 | 390.7 | 327.8 | 70 | 436.6 | 366.4 |
| 331 | 253.6 | 212.8 | 391 | 299.5 | 251.3 | 451 | 345.5 | 289.9 | 511 | 391.5 | 328.4 | 571 | 437.4 | 367.0 |
| 32 | 254.3 | 213.4 | 92 | 300.3 | 252.0 | 52 | 346.3 | 290.5 | 12 | 392.2 | 329.1 | 72 | 438.2 | 367.7 |
| 33 | 255.1 | 214.1 | 93 | 301.1 | 252.6 | 53 | 347.0 | 291.2 | 13 | 393.0 | 329.7 | 73 | 438.9 | 368.3 |
| 34 | 255.9 | 214.7 | 94 | 301.8 | 253.3 | 54 | 347.8 | 291.8 | 14 | 393.8 | 330.4 | 74 | 439.7 | 369.0 |
| 35 | 256.6 | 215.3 | 95 | 302.6 | 253.9 | 55 | 348.6 | 292.5 | 15 | 394.5 | 331.0 | 75 | 440.5 | 369.6 |
| 36 | 257.4 | 216.0 | 96 | 303.4 | 254.6 | 56 | 349.3 | 293.1 | 16 | 395.3 | 331.6 | 76 | 441.2 | 370.2 |
| 37 | 258.2 | 216.6 | 97 | 304.1 | 255.2 | 57 | 350.1 | 293.8 | 17 | 396.1 | 332.3 | 77 | 442.0 | 370.9 |
| 38 | 258.9 | 217.3 | 98 | 304.9 | 255.8 | 58 | 350.8 | 294.4 | 18 | 396.8 | 332.9 | 78 | 442.8 | 371.5 |
| 39 | 259.7 | 217.9 | 99 | 305.7 | 256.5 | 59 | 351.6 | 295.0 | 19 | 397.6 | 333.6 | 79 | 443.5 | 372.2 |
| 40 | 260.5 | 218.6 | 400 | 306.4 | 257.1 | 60 | 352.4 | 295.7 | 20 | 398.3 | 334.2 | 80 | 444.3 | 372.8 |
| 341 | 261.2 | 219.2 | 401 | 307.2 | 257.8 | 461 | 353.1 | 296.3 | 521 | 399.1 | 334.9 | 581 | 445.1 | 373.5 |
| 42 | 262.0 | 219.8 | 02 | 308.0 | 258.4 | 62 | 353.9 | 297.0 | 22 | 399.9 | 335.5 | 82 | 445.8 | 374.1 |
| 43 | 262.8 | 220.5 | 03 | 308.7 | 259.1 | 63 | 354.7 | 297.6 | 23 | 400.6 | 336.1 | 83 | 446.6 | 374.8 |
| 44 | 263.5 | 221.1 | 04 | 309.5 | 259.7 | 64 | 355.4 | 298.3 | 24 | 401.4 | 336.8 | 84 | 447.4 | 375.4 |
| 45 | 264.3 | 221.8 | 05 | 310.2 | 260.3 | 65 | 356.2 | 298.9 | 25 | 402.2 | 337.4 | 85 | 448.1 | 376.0 |
| 46 | 265.1 | 222.4 | 06 | 311.0 | 261.0 | 66 | 357.0 | 299.5 | 26 | 402.9 | 338.1 | 86 | 448.9 | 376.7 |
| 47 | 265.8 | 223.1 | 07 | 311.8 | 261.6 | 67 | 357.7 | 300.2 | 27 | 403.7 | 338.7 | 87 | 449.7 | 377.3 |
| 48 | 266.6 | 223.7 | 08 | 312.5 | 262.3 | 68 | 358.5 | 300.8 | 28 | 404.5 | 339.4 | 88 | 450.4 | 378.0 |
| 49 | 267.4 | 224.3 | 09 | 313.3 | 262.9 | 69 | 359.3 | 301.5 | 29 | 405.2 | 340.0 | 89 | 451.2 | 378.6 |
| 50 | 268.1 | 225.0 | 10 | 314.1 | 263.6 | 70 | 360.0 | 302.1 | 30 | 406.0 | 340.6 | 90 | 452.0 | 379.2 |
| 351 | 268.9 | 225.6 | 411 | 314.8 | 264.2 | 471 | 360.8 | 302.8 | 531 | 406.8 | 341.3 | 591 | 452.7 | 379.9 |
| 52 | 269.6 | 226.3 | 12 | 315.6 | 264.8 | 72 | 361.6 | 303.4 | 32 | 407.5 | 341.9 | 92 | 453.5 | 380.5 |
| 53 | 270.4 | 226.9 | 13 | 316.4 | 265.5 | 73 | 362.3 | 304.0 | 33 | 408.3 | 342.6 | 93 | 454.3 | 381.2 |
| 54 | 271.2 | 227.6 | 14 | 317.1 | 266.1 | 74 | 363.1 | 304.7 | 34 | 409.1 | 343.2 | 94 | 455.0 | 381.8 |
| 55 | 271.9 | 228.2 | 15 | 317.9 | 266.8 | 75 | 363.9 | 305.3 | 35 | 409.8 | 343.9 | 95 | 455.8 | 382.4 |
| 56 | 272.7 | 228.8 | 16 | 318.7 | 267.4 | 76 | 364.6 | 306.0 | 36 | 410.6 | 344.5 | 96 | 456.6 | 383.1 |
| 57 | 273.5 | 229.5 | 17 | 319.4 | 268.1 | 77 | 365.4 | 306.6 | 37 | 411.4 | 345.2 | 97 | 457.3 | 383.7 |
| 58 | 274.2 | 230.1 | 18 | 320.2 | 268.7 | 78 | 366.2 | 307.3 | 38 | 412.1 | 345.8 | 98 | 458.1 | 384.4 |
| 59 | 275.0 | 230.8 | 19 | 321.0 | 269.3 | 79 | 366.9 | 307.9 | 39 | 412.9 | 346.4 | 99 | 458.9 | 385.0 |
| 60 | 275.8 | 231.4 | 20 | 321.7 | 270.0 | 80 | 367.7 | 308.5 | 40 | 413.7 | 347.1 | 600 | 459.6 | 385.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

50° (130°, 230°, 310°).

# TABLE 2.

Difference of Latitude and Departure for 41° (139°, 221°, 319°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.8 | 0.7 | 61 | 46.0 | 40.0 | 121 | 91.3 | 79.4 | 181 | 136.6 | 118.7 | 241 | 181.9 | 158.1 |
| 2 | 1.5 | 1.3 | 62 | 46.8 | 40.7 | 22 | 92.1 | 80.0 | 82 | 137.4 | 119.4 | 42 | 182.6 | 158.8 |
| 3 | 2.3 | 2.0 | 63 | 47.5 | 41.3 | 23 | 92.8 | 80.7 | 83 | 138.1 | 120.1 | 43 | 183.4 | 159.4 |
| 4 | 3.0 | 2.6 | 64 | 48.3 | 42.0 | 24 | 93.6 | 81.4 | 84 | 138.9 | 120.7 | 44 | 184.1 | 160.1 |
| 5 | 3.8 | 3.3 | 65 | 49.1 | 42.6 | 25 | 94.3 | 82.0 | 85 | 139.6 | 121.4 | 45 | 184.9 | 160.7 |
| 6 | 4.5 | 3.9 | 66 | 49.8 | 43.3 | 26 | 95.1 | 82.7 | 86 | 140.4 | 122.0 | 46 | 185.7 | 161.4 |
| 7 | 5.3 | 4.6 | 67 | 50.6 | 44.0 | 27 | 95.8 | 83.3 | 87 | 141.1 | 122.7 | 47 | 186.4 | 162.0 |
| 8 | 6.0 | 5.2 | 68 | 51.3 | 44.6 | 28 | 96.6 | 84.0 | 88 | 141.9 | 123.3 | 48 | 187.2 | 162.7 |
| 9 | 6.8 | 5.9 | 69 | 52.1 | 45.3 | 29 | 97.4 | 84.6 | 89 | 142.6 | 124.0 | 49 | 187.9 | 163.4 |
| 10 | 7.5 | 6.6 | 70 | 52.8 | 45.9 | 30 | 98.1 | 85.3 | 90 | 143.4 | 124.7 | 50 | 188.7 | 164.0 |
| 11 | 8.3 | 7.2 | 71 | 53.6 | 46.6 | 131 | 98.9 | 85.9 | 191 | 144.1 | 125.3 | 251 | 189.4 | 164.7 |
| 12 | 9.1 | 7.9 | 72 | 54.3 | 47.2 | 32 | 99.6 | 86.6 | 92 | 144.9 | 126.0 | 52 | 190.2 | 165.3 |
| 13 | 9.8 | 8.5 | 73 | 55.1 | 47.9 | 33 | 100.4 | 87.3 | 93 | 145.7 | 126.6 | 53 | 190.9 | 166.0 |
| 14 | 10.6 | 9.2 | 74 | 55.8 | 48.5 | 34 | 101.1 | 87.9 | 94 | 146.4 | 127.3 | 54 | 191.7 | 166.6 |
| 15 | 11.3 | 9.8 | 75 | 56.6 | 49.2 | 35 | 101.9 | 88.6 | 95 | 147.2 | 127.9 | 55 | 192.5 | 167.3 |
| 16 | 12.1 | 10.5 | 76 | 57.4 | 49.9 | 36 | 102.6 | 89.2 | 96 | 147.9 | 128.6 | 56 | 193.2 | 168.0 |
| 17 | 12.8 | 11.2 | 77 | 58.1 | 50.5 | 37 | 103.4 | 89.9 | 97 | 148.7 | 129.2 | 57 | 194.0 | 168.6 |
| 18 | 13.6 | 11.8 | 78 | 58.9 | 51.2 | 38 | 104.1 | 90.5 | 98 | 149.4 | 129.9 | 58 | 194.7 | 169.3 |
| 19 | 14.3 | 12.5 | 79 | 59.6 | 51.8 | 39 | 104.9 | 91.2 | 99 | 150.2 | 130.6 | 59 | 195.5 | 169.9 |
| 20 | 15.1 | 13.1 | 80 | 60.4 | 52.5 | 40 | 105.7 | 91.8 | 200 | 150.9 | 131.2 | 60 | 196.2 | 170.6 |
| 21 | 15.8 | 13.8 | 81 | 61.1 | 53.1 | 141 | 106.4 | 92.5 | 201 | 151.7 | 131.9 | 261 | 197.0 | 171.2 |
| 22 | 16.6 | 14.4 | 82 | 61.9 | 53.8 | 42 | 107.2 | 93.2 | 02 | 152.5 | 132.5 | 62 | 197.7 | 171.9 |
| 23 | 17.4 | 15.1 | 83 | 62.6 | 54.5 | 43 | 107.9 | 93.8 | 03 | 153.2 | 133.2 | 63 | 198.5 | 172.5 |
| 24 | 18.1 | 15.7 | 84 | 63.4 | 55.1 | 44 | 108.7 | 94.5 | 04 | 154.0 | 133.8 | 64 | 199.2 | 173.2 |
| 25 | 18.9 | 16.4 | 85 | 64.2 | 55.8 | 45 | 109.4 | 95.1 | 05 | 154.7 | 134.5 | 65 | 200.0 | 173.9 |
| 26 | 19.6 | 17.1 | 86 | 64.9 | 56.4 | 46 | 110.2 | 95.8 | 06 | 155.5 | 135.1 | 66 | 200.8 | 174.5 |
| 27 | 20.4 | 17.7 | 87 | 65.7 | 57.1 | 47 | 110.9 | 96.4 | 07 | 156.2 | 135.8 | 67 | 201.5 | 175.2 |
| 28 | 21.1 | 18.4 | 88 | 66.4 | 57.7 | 48 | 111.7 | 97.1 | 08 | 157.0 | 136.5 | 68 | 202.3 | 175.8 |
| 29 | 21.9 | 19.0 | 89 | 67.2 | 58.4 | 49 | 112.5 | 97.8 | 09 | 157.7 | 137.1 | 69 | 203.0 | 176.5 |
| 30 | 22.6 | 19.7 | 90 | 67.9 | 59.0 | 50 | 113.2 | 98.4 | 10 | 158.5 | 137.8 | 70 | 203.8 | 177.1 |
| 31 | 23.4 | 20.3 | 91 | 68.7 | 59.7 | 151 | 114.0 | 99.1 | 211 | 159.2 | 138.4 | 271 | 204.5 | 177.8 |
| 32 | 24.2 | 21.0 | 92 | 69.4 | 60.4 | 52 | 114.7 | 99.7 | 12 | 160.0 | 139.1 | 72 | 205.3 | 178.4 |
| 33 | 24.9 | 21.6 | 93 | 70.2 | 61.0 | 53 | 115.5 | 100.4 | 13 | 160.8 | 139.7 | 73 | 206.0 | 179.1 |
| 34 | 25.7 | 22.3 | 94 | 70.9 | 61.7 | 54 | 116.2 | 101.0 | 14 | 161.5 | 140.4 | 74 | 206.8 | 179.8 |
| 35 | 26.4 | 23.0 | 95 | 71.7 | 62.3 | 55 | 117.0 | 101.7 | 15 | 162.3 | 141.1 | 75 | 207.5 | 180.4 |
| 36 | 27.2 | 23.6 | 96 | 72.5 | 63.0 | 56 | 117.7 | 102.3 | 16 | 163.0 | 141.7 | 76 | 208.3 | 181.1 |
| 37 | 27.9 | 24.3 | 97 | 73.2 | 63.6 | 57 | 118.5 | 103.0 | 17 | 163.8 | 142.4 | 77 | 209.1 | 181.7 |
| 38 | 28.7 | 24.9 | 98 | 74.0 | 64.3 | 58 | 119.2 | 103.7 | 18 | 164.5 | 143.0 | 78 | 209.8 | 182.4 |
| 39 | 29.4 | 25.6 | 99 | 74.7 | 64.9 | 59 | 120.0 | 104.3 | 19 | 165.3 | 143.7 | 79 | 210.6 | 183.0 |
| 40 | 30.2 | 26.2 | 100 | 75.5 | 65.6 | 60 | 120.8 | 105.0 | 20 | 166.0 | 144.3 | 80 | 211.3 | 183.7 |
| 41 | 30.9 | 26.9 | 101 | 76.2 | 66.3 | 161 | 121.5 | 105.6 | 221 | 166.8 | 145.0 | 281 | 212.1 | 184.4 |
| 42 | 31.7 | 27.6 | 02 | 77.0 | 66.9 | 62 | 122.3 | 106.3 | 22 | 167.5 | 145.6 | 82 | 212.8 | 185.0 |
| 43 | 32.5 | 28.2 | 03 | 77.7 | 67.6 | 63 | 123.0 | 106.9 | 23 | 168.3 | 146.3 | 83 | 213.6 | 185.7 |
| 44 | 33.2 | 28.9 | 04 | 78.5 | 68.2 | 64 | 123.8 | 107.6 | 24 | 169.1 | 147.0 | 84 | 214.3 | 186.3 |
| 45 | 34.0 | 29.5 | 05 | 79.2 | 68.9 | 65 | 124.5 | 108.2 | 25 | 169.8 | 147.6 | 85 | 215.1 | 187.0 |
| 46 | 34.7 | 30.2 | 06 | 80.0 | 69.5 | 66 | 125.3 | 108.9 | 26 | 170.6 | 148.3 | 86 | 215.8 | 187.6 |
| 47 | 35.5 | 30.8 | 07 | 80.8 | 70.2 | 67 | 126.0 | 109.6 | 27 | 171.3 | 148.9 | 87 | 216.6 | 188.3 |
| 48 | 36.2 | 31.5 | 08 | 81.5 | 70.9 | 68 | 126.8 | 110.2 | 28 | 172.1 | 149.6 | 88 | 217.4 | 188.9 |
| 49 | 37.0 | 32.1 | 09 | 82.3 | 71.5 | 69 | 127.5 | 110.9 | 29 | 172.8 | 150.2 | 89 | 218.1 | 189.6 |
| 50 | 37.7 | 32.8 | 10 | 83.0 | 72.2 | 70 | 128.3 | 111.5 | 30 | 173.6 | 150.9 | 90 | 218.9 | 190.3 |
| 51 | 38.5 | 33.5 | 111 | 83.8 | 72.8 | 171 | 129.1 | 112.2 | 231 | 174.3 | 151.5 | 291 | 219.6 | 190.9 |
| 52 | 39.2 | 34.1 | 12 | 84.5 | 73.5 | 72 | 129.8 | 112.8 | 32 | 175.1 | 152.2 | 92 | 220.4 | 191.6 |
| 53 | 40.0 | 34.8 | 13 | 85.3 | 74.1 | 73 | 130.6 | 113.5 | 33 | 175.8 | 152.9 | 93 | 221.1 | 192.2 |
| 54 | 40.8 | 35.4 | 14 | 86.0 | 74.8 | 74 | 131.3 | 114.2 | 34 | 176.6 | 153.5 | 94 | 221.9 | 192.9 |
| 55 | 41.5 | 36.1 | 15 | 86.8 | 75.4 | 75 | 132.1 | 114.8 | 35 | 177.4 | 154.2 | 95 | 222.6 | 193.5 |
| 56 | 42.3 | 36.7 | 16 | 87.5 | 76.1 | 76 | 132.8 | 115.5 | 36 | 178.1 | 154.8 | 96 | 223.4 | 194.2 |
| 57 | 43.0 | 37.4 | 17 | 88.3 | 76.8 | 77 | 133.6 | 116.1 | 37 | 178.9 | 155.5 | 97 | 224.1 | 194.8 |
| 58 | 43.8 | 38.1 | 18 | 89.1 | 77.4 | 78 | 134.3 | 116.8 | 38 | 179.6 | 156.1 | 98 | 224.9 | 195.5 |
| 59 | 44.5 | 38.7 | 19 | 89.8 | 78.1 | 79 | 135.1 | 117.4 | 39 | 180.4 | 156.8 | 99 | 225.7 | 196.2 |
| 60 | 45.3 | 39.4 | 20 | 90.6 | 78.7 | 80 | 135.8 | 118.1 | 40 | 181.1 | 157.5 | 300 | 226.4 | 196.8 |

| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

49° (131°, 229°, 311°).

TABLE 2. [Page 449·

Difference of Latitude and Departure for 41° (139°, 221°, 319°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 227.2 | 197.5 | 361 | 272.5 | 236.9 | 421 | 317.7 | 276.2 | 481 | 363.0 | 315.6 | 541 | 408.3 | 354.9 |
| 02 | 227.9 | 198.1 | 62 | 273.2 | 237.5 | 22 | 318.5 | 276.9 | 82 | 363.8 | 316.2 | 42 | 409.0 | 355.6 |
| 03 | 228.7 | 198.8 | 63 | 274.0 | 238.2 | 23 | 319.2 | 277.5 | 83 | 364.5 | 316.9 | 43 | 409.8 | 356.2 |
| 04 | 229.4 | 199.4 | 64 | 274.7 | 238.8 | 24 | 320.0 | 278.2 | 84 | 365.3 | 317.5 | 44 | 410.6 | 356.9 |
| 05 | 230.2 | 200.1 | 65 | 275.5 | 239.5 | 25 | 320.8 | 278.8 | 85 | 366.0 | 318.2 | 45 | 411.3 | 357.5 |
| 06 | 230.9 | 200.8 | 66 | 276.2 | 240.1 | 26 | 321.5 | 279.5 | 86 | 366.8 | 318.8 | 46 | 412.1 | 358.2 |
| 07 | 231.7 | 201.4 | 67 | 277.0 | 240.8 | 27 | 322.3 | 280.1 | 87 | 367.5 | 319.5 | 47 | 412.8 | 358.8 |
| 08 | 232.5 | 202.1 | 68 | 277.7 | 241.4 | 28 | 323.0 | 280.8 | 88 | 368.3 | 320.1 | 48 | 413.6 | 359.5 |
| 09 | 233.2 | 202.7 | 69 | 278.5 | 242.1 | 29 | 323.8 | 281.5 | 89 | 369.0 | 320.8 | 49 | 414.3 | 360.2 |
| 10 | 234.0 | 203.4 | 70 | 279.2 | 242.7 | 30 | 324.5 | 282.1 | 90 | 369.8 | 321.5 | 50 | 415.1 | 360.8 |
| 311 | 234.7 | 204.0 | 371 | 280.0 | 243.4 | 431 | 325.3 | 282.8 | 491 | 370.6 | 322.1 | 551 | 415.8 | 361.5 |
| 12 | 235.5 | 204.7 | 72 | 280.8 | 244.1 | 32 | 326.0 | 283.4 | 92 | 371.3 | 322.8 | 52 | 416.6 | 362.1 |
| 13 | 236.2 | 205.4 | 73 | 281.5 | 244.7 | 33 | 326.8 | 284.1 | 93 | 372.1 | 323.4 | 53 | 417.3 | 362.8 |
| 14 | 237.0 | 206.0 | 74 | 282.3 | 245.4 | 34 | 327.5 | 284.7 | 94 | 372.8 | 324.1 | 54 | 418.1 | 363.4 |
| 15 | 237.7 | 206.7 | 75 | 283.0 | 246.0 | 35 | 328.3 | 285.4 | 95 | 373.6 | 324.7 | 55 | 418.9 | 364.1 |
| 16 | 238.5 | 207.3 | 76 | 283.8 | 246.7 | 36 | 329.1 | 286.0 | 96 | 374.3 | 325.4 | 56 | 419.6 | 364.8 |
| 17 | 239.2 | 208.0 | 77 | 284.5 | 247.3 | 37 | 329.8 | 286.7 | 97 | 375.1 | 326.0 | 57 | 420.4 | 365.4 |
| 18 | 240.0 | 208.6 | 78 | 285.3 | 248.0 | 38 | 330.6 | 287.4 | 98 | 375.8 | 326.7 | 58 | 421.1 | 366.1 |
| 19 | 240.8 | 209.3 | 79 | 286.0 | 248.7 | 39 | 331.3 | 288.0 | 99 | 376.6 | 327.4 | 59 | 421.9 | 366.7 |
| 20 | 241.5 | 209.9 | 80 | 286.8 | 249.3 | 40 | 332.1 | 288.7 | 500 | 377.3 | 328.0 | 60 | 422.6 | 367.4 |
| 321 | 242.3 | 210.6 | 381 | 287.5 | 250.0 | 441 | 332.8 | 289.3 | 501 | 378.1 | 328.7 | 561 | 423.4 | 368.0 |
| 22 | 243.0 | 211.3 | 82 | 288.3 | 250.6 | 42 | 333.6 | 290.0 | 02 | 378.9 | 329.3 | 62 | 424.1 | 368.7 |
| 23 | 243.8 | 211.9 | 83 | 289.1 | 251.3 | .43 | 334.3 | 290.6 | 03 | 379.6 | 330.0 | ,63 | 424.9 | 369.4 |
| 24 | 244.5 | 212.6 | 84 | 289.8 | 251.9 | 44 | 335.1 | 291.3 | 04 | 380.4 | 330.6 | 64 | 425.7 | 370.0 |
| 25 | 245.3 | 213.2 | 85 | 290.6 | 252.6 | 45 | 335.8 | 292.0 | 05 | 381.1 | 331.3 | 65 | 426.4 | 370.7 |
| 26 | 246.0 | 213.9 | 86 | 291.3 | 253.2 | 46 | 336.6 | 292.6 | 06 | 381.9 | 332.0 | 66 | 427.2 | 371.3 |
| 27 | 246.8 | 214.5 | 87 | 292.1 | 253.9 | 47 | 337.4 | 293.3 | 07 | 382.6 | 332.6 | 67 | 427.9 | 372.0 |
| 28 | 247.5 | 215.2 | 88 | 292.8 | 254.6 | 48 | 338.1 | 293.9 | 08 | 383.4 | 333.3 | 68 | 428.7 | 372.6 |
| 29 | 248.3 | 215.9 | 89 | 293.6 | 255.2 | 49 | 338.9 | 294.6 | 09 | 384.1 | 333.9 | 69 | 429.4 | 373.3 |
| 30 | 249.1 | 216.5 | 90 | 294.3 | 255.9 | 50 | 339.6 | 295.2 | 10 | 384.9 | 334.6 | 70 | 430.2 | 374.0 |
| 331 | 249.8 | 217.2 | 391 | 295.1 | 256.5 | 451 | 340.4 | 295.9 | 511 | 385.7 | 335.2 | 571 | 430.9 | 374.6 |
| 32 | 250.6 | 217.8 | 92 | 295.8 | 257.2 | 52 | 341.1 | 296.5 | 12 | 386.4 | 335.9 | 72 | 431.7 | 375.3 |
| 33 | 251.3 | 218.5 | 93 | 296.6 | 257.8 | 53 | 341.9 | 297.2 | 13 | 387.2 | 336.5 | 73 | 432.4 | 375.9 |
| 34 | 252.1 | 219.1 | 94 | 297.4 | 258.5 | 54 | 342.6 | 297.9 | 14 | 387.9 | 337.2 | 74 | 433.2 | 376.6 |
| 35 | 252.8 | 219.8 | 95 | 298.1 | 259.2 | 55 | 343.4 | 298.5 | 15 | 388.7 | 337.9 | 75 | 434.0 | 377.2 |
| 36 | 253.6 | 220.4 | 96 | 298.9 | 259.8 | 56 | 344.1 | 299.2 | 16 | 389.4 | 338.5 | 76 | 434.7 | 377.9 |
| 37 | 254.3 | 221.1 | 97 | 299.6 | 260.5 | 57 | 344.9 | 299.8 | 17 | 390.2 | 339.2 | 77 | 435.5 | 378.5 |
| 38 | 255.1 | 221.8 | 98 | 300.4 | 261.1 | 58 | 345.7 | 300.5 | 18 | 390.9 | 339.8 | 78 | 436.2 | 379.2 |
| 39 | 255.8 | 222.4 | 99 | 301.1 | 261.8 | 59 | 346.4 | 301.1 | 19 | 391.7 | 340.5 | 79 | 437.0 | 379.8 |
| 40 | 256.6 | 223.1 | 400 | 301.9 | 262.4 | 60 | 347.2 | 301.8 | 20 | 392.4 | 341.1 | 80 | 437.7 | 380.5 |
| 341 | 257.4 | 223.7 | 401 | 302.6 | 263.1 | 461 | 347.9 | 302.5 | 521 | 393.2 | 341.8 | 581 | 438.5 | 381.2 |
| 42 | 258.1 | 224.4 | 02 | 303.4 | 263.7 | ·62 | 348.7 | 303.1 | 22 | 394.0 | 342.5 | 82 | 439.2 | 381.8 |
| 43 | 258.9 | 225.0 | 03 | 304.2 | 264.4 | 63 | 349.4 | 303.8 | 23 | 394.7 | 343.1 | 83 | 440.0 | 382.5 |
| 44 | 259.6 | 225.7 | 04 | 304.9 | 265.1 | 64 | 350.2 | 304.4 | 24 | 395.5 | 343.8 | 84 | 440.7 | 383.2 |
| 45 | 260.4 | 226.3 | 05 | 305.7 | 265.7 | 65 | 350.9 | 305.1 | 25 | 396.2 | 344.4 | 85 | 441.5 | 383.8 |
| 46 | 261.1 | 227.0 | 06 | 306.4 | 266.4 | 66 | 351.7 | 305.7 | 26 | 397.0 | 345.1 | 86 | 442.3 | 384.5 |
| 47 | 261.9 | 227.7 | 07 | 307.2 | 267.0 | 67 | 352.5 | 306.4 | 27 | 397.7 | 345.7 | 87 | 443.0 | 385.1 |
| 48 | 262.6 | 228.3 | 08 | 307.9 | 267.7 | 68 | 353.2 | 307.0 | 28 | 398.5 | 346.4 | 88 | 443.8 | 385.8 |
| 49 | 263.4 | 229.0 | 09 | 308.7 | 268.3 | 69 | 354.0 | 307.7 | 29 | 399.2 | 347.0 | 89 | 444.5 | 386.4 |
| 50 | 264.2 | 229.6 | 10 | 309.4 | 269.0 | 70 | 354.7 | 308.4 | 30 | 400.0 | 347.7 | 90 | 445.3 | 387.1 |
| 351 | 264.9 | 230.3 | 411 | 310.2 | 269.6 | 471 | 355.5 | 309.0 | 531 | 400.7 | 348.4 | 591 | 446.0 | 387.7 |
| 52 | 265.7 | 230.9 | 12 | 310.9 | 270.3 | 72 | 356.2 | 309.7 | 32 | 401.5 | 349.0 | 92 | 446.8 | 388.4 |
| 53 | 266.4 | 231.6 | 13 | 311.7 | 271.0 | 73 | 357.0 | 310.3 | 33 | 402.2 | 349.7 | 93 | 447.5 | 389.1 |
| 54 | 267.2 | 232.3 | 14 | 312.5 | 271.6 | 74 | 357.7 | 311.0 | 34 | 403.0 | 350.3 | 94 | 448.3 | 389.7 |
| 55 | 267.9 | 232.9 | 15 | 313.2 | 272.3 | 75 | 358.5 | 311.6 | 35 | 403.8 | 351.0 | 95 | 449.1 | 390.4 |
| 56 | 268.7 | 233.6 | 16 | 314.0 | 272.9 | 76 | 359.2 | 312.3 | 36 | 404.5 | 351.6 | 96 | 449.8 | 391.0 |
| 57 | 269.4 | 234.2 | 17 | 314.7 | 273.6 | 77 | 360.0 | 312.9 | 37 | 405.3 | 352.3 | 97 | 450.6 | 391.7 |
| 58 | 270.2 | 234.9 | 18 | 315.5 | 274.2 | 78 | 360.8 | 313.6 | 38 | 406.0 | 352.9 | 98 | 451.3 | 392.3 |
| 59 | 270.9 | 235.5 | 19 | 316.2 | 274.9 | 79 | 361.5 | 314.3 | 39 | 406.8 | 353.6 | 99 | 452.1 | 393.0 |
| 60 | 271.7 | 236.2 | 20 | 317.0 | 275.6 | 80 | 362.3 | 314.9 | 40 | 407.5 | 354.3 | 600 | 452.8 | 393.6 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

49° (131°, 229°, 311°).

# TABLE 2.

Difference of Latitude and Departure for 42° (138°, 222°, 318°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.7 | 61 | 45.3 | 40.8 | 121 | 89.9 | 81.0 | 181 | 134.5 | 121.1 | 241 | 179.1 | 161.3 |
| 2 | 1.5 | 1.3 | 62 | 46.1 | 41.5 | 22 | 90.7 | 81.6 | 82 | 135.3 | 121.8 | 42 | 179.8 | 161.9 |
| 3 | 2.2 | 2.0 | 63 | 46.8 | 42.2 | 23 | 91.4 | 82.3 | 83 | 136.0 | 122.5 | 43 | 180.6 | 162.6 |
| 4 | 3.0 | 2.7 | 64 | 47.6 | 42.8 | 24 | 92.1 | 83.0 | 84 | 136.7 | 123.1 | 44 | 181.3 | 163.3 |
| 5 | 3.7 | 3.3 | 65 | 48.3 | 43.5 | 25 | 92.9 | 83.6 | 85 | 137.5 | 123.8 | 45 | 182.1 | 163.9 |
| 6 | 4.5 | 4.0 | 66 | 49.0 | 44.2 | 26 | 93.6 | 84.3 | 86 | 138.2 | 124.5 | 46 | 182.8 | 164.6 |
| 7 | 5.2 | 4.7 | 67 | 49.8 | 44.8 | 27 | 94.4 | 85.0 | 87 | 139.0 | 125.1 | 47 | 183.6 | 165.3 |
| 8 | 5.9 | 5.4 | 68 | 50.5 | 45.5 | 28 | 95.1 | 85.6 | 88 | 139.7 | 125.8 | 48 | 184.3 | 165.9 |
| 9 | 6.7 | 6.0 | 69 | 51.3 | 46.2 | 29 | 95.9 | 86.3 | 89 | 140.5 | 126.5 | 49 | 185.0 | 166.6 |
| 10 | 7.4 | 6.7 | 70 | 52.0 | 46.8 | 30 | 96.6 | 87.0 | 90 | 141.2 | 127.1 | 50 | 185.8 | 167.3 |
| 11 | 8.2 | 7.4 | 71 | 52.8 | 47.5 | 131 | 97.4 | 87.7 | 191 | 141.9 | 127.8 | 251 | 186.5 | 168.0 |
| 12 | 8.9 | 8.0 | 72 | 53.5 | 48.2 | 32 | 98.1 | 88.3 | 92 | 142.7 | 128.5 | 52 | 187.3 | 168.6 |
| 13 | 9.7 | 8.7 | 73 | 54.2 | 48.8 | 33 | 98.8 | 89.0 | 93 | 143.4 | 129.1 | 53 | 188.0 | 169.3 |
| 14 | 10.4 | 9.4 | 74 | 55.0 | 49.5 | 34 | 99.6 | 89.7 | 94 | 144.2 | 129.8 | 54 | 188.8 | 170.0 |
| 15 | 11.1 | 10.0 | 75 | 55.7 | 50.2 | 35 | 100.3 | 90.3 | 95 | 144.9 | 130.5 | 55 | 189.5 | 170.6 |
| 16 | 11.9 | 10.7 | 76 | 56.5 | 50.9 | 36 | 101.1 | 91.0 | 96 | 145.7 | 131.1 | 56 | 190.2 | 171.3 |
| 17 | 12.6 | 11.4 | 77 | 57.2 | 51.5 | 37 | 101.8 | 91.7 | 97 | 146.4 | 131.8 | 57 | 191.0 | 172.0 |
| 18 | 13.4 | 12.0 | 78 | 58.0 | 52.2 | 38 | 102.6 | 92.3 | 98 | 147.1 | 132.5 | 58 | 191.7 | 172.6 |
| 19 | 14.1 | 12.7 | 79 | 58.7 | 52.9 | 39 | 103.3 | 93.0 | 99 | 147.9 | 133.2 | 59 | 192.5 | 173.3 |
| 20 | 14.9 | 13.4 | 80 | 59.5 | 53.5 | 40 | 104.0 | 93.7 | 200 | 148.6 | 133.8 | 60 | 193.2 | 174.0 |
| 21 | 15.6 | 14.1 | 81 | 60.2 | 54.2 | 141 | 104.8 | 94.3 | 201 | 149.4 | 134.5 | 261 | 194.0 | 174.6 |
| 22 | 16.3 | 14.7 | 82 | 60.9 | 54.9 | 42 | 105.5 | 95.0 | 02 | 150.1 | 135.2 | 62 | 194.7 | 175.3 |
| 23 | 17.1 | 15.4 | 83 | 61.7 | 55.5 | 43 | 106.3 | 95.7 | 03 | 150.9 | 135.8 | 63 | 195.4 | 176.0 |
| 24 | 17.8 | 16.1 | 84 | 62.4 | 56.2 | 44 | 107.0 | 96.4 | 04 | 151.6 | 136.5 | 64 | 196.2 | 176.7 |
| 25 | 18.6 | 16.7 | 85 | 63.2 | 56.9 | 45 | 107.8 | 97.0 | 05 | 152.3 | 137.2 | 65 | 196.9 | 177.3 |
| 26 | 19.3 | 17.4 | 86 | 63.9 | 57.5 | 46 | 108.5 | 97.7 | 06 | 153.1 | 137.8 | 66 | 197.7 | 178.0 |
| 27 | 20.1 | 18.1 | 87 | 64.7 | 58.2 | 47 | 109.2 | 98.4 | 07 | 153.8 | 138.5 | 67 | 198.4 | 178.7 |
| 28 | 20.8 | 18.7 | 88 | 65.4 | 58.9 | 48 | 110.0 | 99.0 | 08 | 154.6 | 139.2 | 68 | 199.2 | 179.3 |
| 29 | 21.6 | 19.4 | 89 | 66.1 | 59.6 | 49 | 110.7 | 99.7 | 09 | 155.3 | 139.8 | 69 | 199.9 | 180.0 |
| 30 | 22.3 | 20.1 | 90 | 66.9 | 60.2 | 50 | 111.5 | 100.4 | 10 | 156.1 | 140.5 | 70 | 200.6 | 180.7 |
| 31 | 23.0 | 20.7 | 91 | 67.6 | 60.9 | 151 | 112.2 | 101.0 | 211 | 156.8 | 141.2 | 271 | 201.4 | 181.3 |
| 32 | 23.8 | 21.4 | 92 | 68.4 | 61.6 | 52 | 113.0 | 101.7 | 12 | 157.5 | 141.9 | 72 | 202.1 | 182.0 |
| 33 | 24.5 | 22.1 | 93 | 69.1 | 62.2 | 53 | 113.7 | 102.4 | 13 | 158.3 | 142.5 | 73 | 202.9 | 182.7 |
| 34 | 25.3 | 22.8 | 94 | 69.9 | 62.9 | 54 | 114.4 | 103.0 | 14 | 159.0 | 143.2 | 74 | 203.6 | 183.3 |
| 35 | 26.0 | 23.4 | 95 | 70.6 | 63.6 | 55 | 115.2 | 103.7 | 15 | 159.8 | 143.9 | 75 | 204.4 | 184.0 |
| 36 | 26.8 | 24.1 | 96 | 71.3 | 64.2 | 56 | 115.9 | 104.4 | 16 | 160.5 | 144.5 | 76 | 205.1 | 184.7 |
| 37 | 27.5 | 24.8 | 97 | 72.1 | 64.9 | 57 | 116.7 | 105.1 | 17 | 161.3 | 145.2 | 77 | 205.9 | 185.3 |
| 38 | 28.2 | 25.4 | 98 | 72.8 | 65.6 | 58 | 117.4 | 105.7 | 18 | 162.0 | 145.9 | 78 | 206.6 | 186.0 |
| 39 | 29.0 | 26.1 | 99 | 73.6 | 66.2 | 59 | 118.2 | 106.4 | 19 | 162.7 | 146.5 | 79 | 207.3 | 186.7 |
| 40 | 29.7 | 26.8 | 100 | 74.3 | 66.9 | 60 | 118.9 | 107.1 | 20 | 163.5 | 147.2 | 80 | 208.1 | 187.4 |
| 41 | 30.5 | 27.4 | 101 | 75.1 | 67.6 | 161 | 119.6 | 107.7 | 221 | 164.2 | 147.9 | 281 | 208.8 | 188.0 |
| 42 | 31.2 | 28.1 | 02 | 75.8 | 68.3 | 62 | 120.4 | 108.4 | 22 | 165.0 | 148.5 | 82 | 209.6 | 188.7 |
| 43 | 32.0 | 28.8 | 03 | 76.5 | 68.9 | 63 | 121.1 | 109.1 | 23 | 165.7 | 149.2 | 83 | 210.3 | 189.4 |
| 44 | 32.7 | 29.4 | 04 | 77.3 | 69.6 | 64 | 121.9 | 109.7 | 24 | 166.5 | 149.9 | 84 | 211.1 | 190.0 |
| 45 | 33.4 | 30.1 | 05 | 78.0 | 70.3 | 65 | 122.6 | 110.4 | 25 | 167.2 | 150.6 | 85 | 211.8 | 190.7 |
| 46 | 34.2 | 30.8 | 06 | 78.8 | 70.9 | 66 | 123.4 | 111.1 | 26 | 168.0 | 151.2 | 86 | 212.5 | 191.4 |
| 47 | 34.9 | 31.4 | 07 | 79.5 | 71.6 | 67 | 124.1 | 111.7 | 27 | 168.7 | 151.9 | 87 | 213.3 | 192.0 |
| 48 | 35.7 | 32.1 | 08 | 80.3 | 72.3 | 68 | 124.8 | 112.4 | 28 | 169.4 | 152.6 | 88 | 214.0 | 192.7 |
| 49 | 36.4 | 32.8 | 09 | 81.0 | 72.9 | 69 | 125.6 | 113.1 | 29 | 170.2 | 153.2 | 89 | 214.8 | 193.4 |
| 50 | 37.2 | 33.5 | 10 | 81.7 | 73.6 | 70 | 126.3 | 113.8 | 30 | 170.9 | 153.9 | 90 | 215.5 | 194.0 |
| 51 | 37.9 | 34.1 | 111 | 82.5 | 74.3 | 171 | 127.1 | 114.4 | 231 | 171.7 | 154.6 | 291 | 216.3 | 194.7 |
| 52 | 38.6 | 34.8 | 12 | 83.2 | 74.9 | 72 | 127.8 | 115.1 | 32 | 172.4 | 155.2 | 92 | 217.0 | 195.4 |
| 53 | 39.4 | 35.5 | 13 | 84.0 | 75.6 | 73 | 128.6 | 115.8 | 33 | 173.2 | 155.9 | 93 | 217.7 | 196.1 |
| 54 | 40.1 | 36.1 | 14 | 84.7 | 76.3 | 74 | 129.3 | 116.4 | 34 | 173.9 | 156.6 | 94 | 218.5 | 196.7 |
| 55 | 40.9 | 36.8 | 15 | 85.5 | 77.0 | 75 | 130.1 | 117.1 | 35 | 174.6 | 157.2 | 95 | 219.2 | 197.4 |
| 56 | 41.6 | 37.5 | 16 | 86.2 | 77.6 | 76 | 130.8 | 117.8 | 36 | 175.4 | 157.9 | 96 | 220.0 | 198.1 |
| 57 | 42.4 | 38.1 | 17 | 86.9 | 78.3 | 77 | 131.5 | 118.4 | 37 | 176.1 | 158.6 | 97 | 220.7 | 198.7 |
| 58 | 43.1 | 38.8 | 18 | 87.7 | 79.0 | 78 | 132.3 | 119.1 | 38 | 176.9 | 159.3 | 98 | 221.5 | 199.4 |
| 59 | 43.8 | 39.5 | 19 | 88.4 | 79.6 | 79 | 133.0 | 119.8 | 39 | 177.6 | 159.9 | 99 | 222.2 | 200.1 |
| 60 | 44.6 | 40.1 | 20 | 89.2 | 80.3 | 80 | 133.8 | 120.4 | 40 | 178.4 | 160.6 | 300 | 222.9 | 200.7 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

48° (132°, 228°, 312°).

TABLE 2.                              [Page 451

Difference of Latitude and Departure for 42° (138°, 222°, 318°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 223.7 | 201.4 | 361 | 268.3 | 241.6 | 421 | 312.9 | 281.7 | 481 | 357.5 | 321.9 | 541 | 402.1 | 362.0 |
| 02 | 224.4 | 202.1 | 62 | 269.0 | 242.2 | 22 | 313.6 | 282.4 | 82 | 358.2 | 322.5 | 42 | 402.8 | 362.7 |
| 03 | 225.2 | 202.8 | 63 | 269.8 | 242.9 | 23 | 314.4 | 283.0 | 83 | 358.9 | 323.2 | 43 | 403.5 | 363.3 |
| 04 | 225.9 | 203.4 | 64 | 270.5 | 243.6 | 24 | 315.1 | 283.7 | 84 | 359.7 | 323.9 | 44 | 404.3 | 364.0 |
| 05 | 226.6 | 204.1 | 65 | 271.2 | 244.2 | 25 | 315.8 | 284.4 | 85 | 360.4 | 324.6 | 45 | 405.0 | 364.7 |
| 06 | 227.4 | 204.8 | 66 | 272.0 | 244.9 | 26 | 316.6 | 285.1 | 86 | 361.2 | 325.2 | 46 | 405.8 | 365.4 |
| 07 | 228.1 | 205.4 | 67 | 272.7 | 245.6 | 27 | 317.3 | 285.7 | 87 | 361.9 | 325.9 | 47 | 406.5 | 366.0 |
| 08 | 228.9 | 206.1 | 68 | 273.5 | 246.2 | 48 | 318.1 | 286.4 | 88 | 362.7 | 326.6 | 48 | 407.2 | 366.7 |
| 09 | 229.6 | 206.8 | 69 | 274.2 | 246.9 | 29 | 318.8 | 287.1 | 89 | 363.4 | 327.2 | 49 | 408.0 | 367.4 |
| 10 | 230.4 | 207.4 | 70 | 275.0 | 247.6 | 30 | 319.6 | 287.7 | 90 | 364.1 | 327.9 | 50 | 408.7 | 368.0 |
| 311 | 231.1 | 208.1 | 371 | 275.7 | 248.3 | 431 | 320.3 | 288.4 | 491 | 364.9 | 328.6 | 551 | 409.5 | 368.7 |
| 12 | 231.9 | 208.8 | 72 | 276.5 | 248.9 | 32 | 321.0 | 289.1 | 92 | 365.6 | 329.2 | 52 | 410.2 | 369.4 |
| 13 | 232.6 | 209.4 | 73 | 277.2 | 249.6 | 33 | 321.8 | 289.7 | 93 | 366.4 | 329.9 | 53 | 411.0 | 370.0 |
| 14 | 233.3 | 210.1 | 74 | 277.9 | 250.3 | 34 | 322.5 | 290.4 | 94 | 367.1 | 330.6 | 54 | 411.7 | 370.7 |
| 15 | 234.1 | 210.8 | 75 | 278.7 | 250.9 | 35 | 323.3 | 291.1 | 95 | 367.9 | 331.3 | 55 | 412.4 | 371.4 |
| 16 | 234.8 | 211.5 | 76 | 279.4 | 251.6 | 36 | 324.0 | 291.7 | 96 | 368.6 | 331.9 | 56 | 413.2 | 372.0 |
| 17 | 235.6 | 212.1 | 77 | 280.2 | 252.3 | 37 | 324.8 | 292.4 | 97 | 369.3 | 332.6 | 57 | 413.9 | 372.7 |
| 18 | 236.3 | 212.8 | 78 | 280.9 | 252.9 | 38 | 325.5 | 293.1 | 98 | 370.1 | 333.3 | 58 | 414.7 | 373.4 |
| 19 | 237.1 | 213.5 | 79 | 281.7 | 253.6 | 39 | 326.2 | 293.8 | 99 | 370.8 | 333.9 | 59 | 415.4 | 374.1 |
| 20 | 237.8 | 214.1 | 80 | 282.4 | 254.3 | 40 | 327.0 | 294.4 | 500 | 371.6 | 334.6 | 60 | 416.2 | 374.7 |
| 321 | 238.6 | 214.8 | 381 | 283.1 | 254.9 | 441 | 327.7 | 295.1 | 501 | 372.3 | 335.3 | 561 | 416.9 | 375.4 |
| 22 | 239.3 | 215.5 | 82 | 283.9 | 255.6 | 42 | 328.5 | 295.8 | 02 | 373.1 | 335.9 | 62 | 417.6 | 376.1 |
| 23 | 240.0 | 216.1 | 83 | 284.6 | 256.3 | 43 | 329.2 | 296.4 | 03 | 373.8 | 336.6 | 63 | 418.4 | 376.7 |
| 24 | 240.8 | 216.8 | 84 | 285.4 | 257.0 | 44 | 330.0 | 297.1 | 04 | 374.5 | 337.2 | 64 | 419.1 | 377.4 |
| 25 | 241.5 | 217.5 | 85 | 286.1 | 257.6 | 45 | 330.7 | 297.8 | 05 | 375.3 | 337.9 | 65 | 419.9 | 378.1 |
| 26 | 242.3 | 218.1 | 86 | 286.9 | 258.3 | 46 | 331.4 | 298.4 | 06 | 376.0 | 338.6 | 66 | 420.6 | 378.7 |
| 27 | 243.0 | 218.8 | 87 | 287.6 | 259.0 | 47 | 332.2 | 299.1 | 07 | 376.8 | 339.3 | 67 | 421.4 | 379.4 |
| 28 | 243.8 | 219.5 | 88 | 288.3 | 259.6 | 48 | 332.9 | 299.8 | 08 | 377.5 | 339.9 | 68 | 422.1 | 380.1 |
| 29 | 244.5 | 220.1 | 89 | 289.1 | 260.3 | 49 | 333.7 | 300.4 | 09 | 378.3 | 340.6 | 69 | 422.8 | 380.7 |
| 30 | 245.2 | 220.8 | 90 | 289.8 | 261.0 | 50 | 334.4 | 301.1 | 10 | 379.0 | 341.3 | 70 | 423.6 | 381.4 |
| 331 | 246.0 | 221.5 | 391 | 290.6 | 261.6 | 451 | 335.2 | 301.8 | 511 | 379.7 | 341.9 | 571 | 424.3 | 382.1 |
| 32 | 246.7 | 222.2 | 92 | 291.3 | 262.3 | 52 | 335.9 | 302.5 | 12 | 380.5 | 342.6 | 72 | 425.1 | 382.8 |
| 33 | 247.5 | 222.8 | 93 | 292.1 | 263.0 | 53 | 336.6 | 303.1 | 13 | 381.2 | 343.3 | 73 | 425.8 | 383.4 |
| 34 | 248.2 | 223.5 | 94 | 292.8 | 263.6 | 54 | 337.4 | 303.8 | 14 | 382.0 | 343.9 | 74 | 426.6 | 384.1 |
| 35 | 249.0 | 224.2 | 95 | 293.5 | 264.3 | 55 | 338.1 | 304.5 | 15 | 382.7 | 344.6 | 75 | 427.3 | 384.8 |
| 36 | 249.7 | 224.8 | 96 | 294.3 | 265.0 | 56 | 338.9 | 305.1 | 16 | 383.5 | 345.3 | 76 | 428.0 | 385.4 |
| 37 | 250.4 | 225.5 | 97 | 295.0 | 265.7 | 57 | 339.6 | 305.8 | 17 | 384.2 | 346.0 | 77 | 428.8 | 386.1 |
| 38 | 251.2 | 226.2 | 98 | 295.8 | 266.3 | 58 | 340.4 | 306.5 | 18 | 384.9 | 346.6 | 78 | 429.5 | 386.8 |
| 39 | 251.9 | 226.8 | 99 | 296.5 | 267.0 | 59 | 341.1 | 307.1 | 19 | 385.7 | 347.3 | 79 | 430.3 | 387.4 |
| 40 | 252.7 | 227.5 | 400 | 297.3 | 267.7 | 60 | 341.8 | 307.8 | 20 | 386.4 | 348.0 | 80 | 431.0 | 388.1 |
| 341 | 253.4 | 228.2 | 401 | 298.0 | 268.3 | 461 | 342.6 | 308.5 | 521 | 387.2 | 348.6 | 581 | 431.8 | 388.8 |
| 42 | 254.2 | 228.8 | 02 | 298.7 | 269.0 | 62 | 343.3 | 309.1 | 22 | 387.9 | 349.3 | 82 | 432.5 | 389.4 |
| 43 | 254.9 | 229.5 | 03 | 299.5 | 269.7 | 63 | 344.1 | 309.8 | 23 | 388.7 | 350.0 | 83 | 433.2 | 390.1 |
| 44 | 255.6 | 230.2 | 04 | 300.2 | 270.3 | 64 | 344.8 | 310.5 | 24 | 389.4 | 350.6 | 84 | 434.0 | 390.8 |
| 45 | 256.4 | 230.9 | 05 | 301.0 | 271.0 | 65 | 345.6 | 311.2 | 25 | 390.1 | 351.3 | 85 | 434.7 | 391.4 |
| 46 | 257.1 | 231.5 | 06 | 301.7 | 271.7 | 66 | 346.3 | 311.8 | 26 | 390.9 | 352.0 | 86 | 435.5 | 392.1 |
| 47 | 257.9 | 232.2 | 07 | 302.5 | 272.3 | 67 | 347.0 | 312.5 | 27 | 391.6 | 352.6 | 87 | 436.2 | 392.8 |
| 48 | 258.6 | 232.9 | 08 | 303.2 | 273.0 | 68 | 347.8 | 313.2 | 28 | 392.4 | 353.3 | 88 | 437.0 | 393.4 |
| 49 | 259.4 | 233.5 | 09 | 303.9 | 273.7 | 69 | 348.5 | 313.8 | 29 | 393.1 | 354.0 | 89 | 437.7 | 394.1 |
| 50 | 260.1 | 234.2 | 10 | 304.7 | 274.3 | 70 | 349.3 | 314.5 | 30 | 393.9 | 354.6 | 90 | 438.4 | 394.8 |
| 351 | 260.8 | 234.9 | 411 | 305.4 | 275.0 | 471 | 350.0 | 315.2 | 531 | 394.6 | 355.3 | 591 | 439.2 | 395.4 |
| 52 | 261.6 | 235.5 | 12 | 306.2 | 275.7 | 72 | 350.8 | 315.8 | 32 | 395.3 | 356.0 | 92 | 440.0 | 396.1 |
| 53 | 262.3 | 236.2 | 13 | 306.9 | 276.4 | 73 | 351.5 | 316.5 | 33 | 396.1 | 356.6 | 93 | 440.7 | 396.8 |
| 54 | 263.1 | 236.9 | 14 | 307.7 | 277.0 | 74 | 352.3 | 317.2 | 34 | 396.8 | 357.3 | 94 | 441.4 | 397.5 |
| 55 | 263.8 | 237.5 | 15 | 308.4 | 277.7 | 75 | 353.0 | 317.8 | 35 | 397.6 | 358.0 | 95 | 442.2 | 398.1 |
| 56 | 264.6 | 238.2 | 16 | 309.1 | 278.4 | 76 | 353.7 | 318.5 | 36 | 398.3 | 358.6 | 96 | 442.9 | 398.8 |
| 57 | 265.3 | 238.9 | 17 | 309.9 | 279.0 | 77 | 354.5 | 319.2 | 37 | 399.1 | 359.3 | 97 | 443.7 | 399.5 |
| 58 | 266.0 | 239.6 | 18 | 310.6 | 279.7 | 78 | 355.2 | 319.9 | 38 | 399.8 | 360.0 | 98 | 444.4 | 400.1 |
| 59 | 266.8 | 240.2 | 19 | 311.4 | 280.4 | 79 | 356.0 | 320.5 | 39 | 400.6 | 360.6 | 99 | 445.2 | 400.8 |
| 60 | 267.5 | 240.9 | 20 | 312.1 | 281.0 | 80 | 356.7 | 321.2 | 40 | 401.3 | 361.3 | 600 | 445.9 | 401.5 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

48° (132°, 228°, 312°).

## TABLE 2.

Difference of Latitude and Departure for 43° (137°, 223°, 317°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.7 | 61 | 44.6 | 41.6 | 121 | 88.5 | 82.5 | 181 | 132.4 | 123.4 | 241 | 176.3 | 164.4 |
| 2 | 1.5 | 1.4 | 62 | 45.3 | 42.3 | 22 | 89.2 | 83.2 | 82 | 133.1 | 124.1 | 42 | 177.0 | 165.0 |
| 3 | 2.2 | 2.0 | 63 | 46.1 | 43.0 | 23 | 90.0 | 83.9 | 83 | 133.8 | 124.8 | 43 | 177.7 | 165.7 |
| 4 | 2.9 | 2.7 | 64 | 46.8 | 43.6 | 24 | 90.7 | 84.6 | 84 | 134.6 | 125.5 | 44 | 178.5 | 166.4 |
| 5 | 3.7 | 3.4 | 65 | 47.5 | 44.3 | 25 | 91.4 | 85.2 | 85 | 135.3 | 126.2 | 45 | 179.2 | 167.1 |
| 6 | 4.4 | 4.1 | 66 | 48.3 | 45.0 | 26 | 92.2 | 85.9 | 86 | 136.0 | 126.9 | 46 | 179.9 | 167.8 |
| 7 | 5.1 | 4.8 | 67 | 49.0 | 45.7 | 27 | 92.9 | 86.6 | 87 | 136.8 | 127.5 | 47 | 180.6 | 168.5 |
| 8 | 5.9 | 5.5 | 68 | 49.7 | 46.4 | 28 | 93.6 | 87.3 | 88 | 137.5 | 128.2 | 48 | 181.4 | 169.1 |
| 9 | 6.6 | 6.1 | 69 | 50.5 | 47.1 | 29 | 94.3 | 88.0 | 89 | 138.2 | 128.9 | 49 | 182.1 | 169.8 |
| 10 | 7.3 | 6.8 | 70 | 51.2 | 47.7 | 30 | 95.1 | 88.7 | 90 | 139.0 | 129.6 | 50 | 182.8 | 170.5 |
| 11 | 8.0 | 7.5 | 71 | 51.9 | 48.4 | 131 | 95.8 | 89.3 | 191 | 139.7 | 130.3 | 251 | 183.6 | 171.2 |
| 12 | 8.8 | 8.2 | 72 | 52.7 | 49.1 | 32 | 96.5 | 90.0 | 92 | 140.4 | 130.9 | 52 | 184.3 | 171.9 |
| 13 | 9.5 | 8.9 | 73 | 53.4 | 49.8 | 33 | 97.3 | 90.7 | 93 | 141.2 | 131.6 | 53 | 185.0 | 172.5 |
| 14 | 10.2 | 9.5 | 74 | 54.1 | 50.5 | 34 | 98.0 | 91.4 | 94 | 141.9 | 132.3 | 54 | 185.8 | 173.2 |
| 15 | 11.0 | 10.2 | 75 | 54.9 | 51.1 | 35 | 98.7 | 92.1 | 95 | 142.6 | 133.0 | 55 | 186.5 | 173.9 |
| 16 | 11.7 | 10.9 | 76 | 55.6 | 51.8 | 36 | 99.5 | 92.8 | 96 | 143.3 | 133.7 | 56 | 187.2 | 174.6 |
| 17 | 12.4 | 11.6 | 77 | 56.3 | 52.5 | 37 | 100.2 | 93.4 | 97 | 144.1 | 134.4 | 57 | 188.0 | 175.3 |
| 18 | 13.2 | 12.3 | 78 | 57.0 | 53.2 | 38 | 100.9 | 94.1 | 98 | 144.8 | 135.0 | 58 | 188.7 | 176.0 |
| 19 | 13.9 | 13.0 | 79 | 57.8 | 53.9 | 39 | 101.7 | 94.8 | 99 | 145.5 | 135.7 | 59 | 189.4 | 176.6 |
| 20 | 14.6 | 13.6 | 80 | 58.5 | 54.6 | 40 | 102.4 | 95.5 | 200 | 146.3 | 136.4 | 60 | 190.2 | 177.3 |
| 21 | 15.4 | 14.3 | 81 | 59.2 | 55.2 | 141 | 103.1 | 96.2 | 201 | 147.0 | 137.1 | 261 | 190.9 | 178.0 |
| 22 | 16.1 | 15.0 | 82 | 60.0 | 55.9 | 42 | 103.9 | 96.8 | 02 | 147.7 | 137.8 | 62 | 191.6 | 178.7 |
| 23 | 16.8 | 15.7 | 83 | 60.7 | 56.6 | 43 | 104.6 | 97.5 | 03 | 148.5 | 138.4 | 63 | 192.3 | 179.4 |
| 24 | 17.6 | 16.4 | 84 | 61.4 | 57.3 | 44 | 105.3 | 98.2 | 04 | 149.2 | 139.1 | 64 | 193.1 | 180.0 |
| 25 | 18.3 | 17.0 | 85 | 62.2 | 58.0 | 45 | 106.0 | 98.9 | 05 | 149.9 | 139.8 | 65 | 193.8 | 180.7 |
| 26 | 19.0 | 17.7 | 86 | 62.9 | 58.7 | 46 | 106.8 | 99.6 | 06 | 150.7 | 140.5 | 66 | 194.5 | 181.4 |
| 27 | 19.7 | 18.4 | 87 | 63.6 | 59.3 | 47 | 107.5 | 100.3 | 07 | 151.4 | 141.2 | 67 | 195.3 | 182.1 |
| 28 | 20.5 | 19.1 | 88 | 64.4 | 60.0 | 48 | 108.2 | 100.9 | 08 | 152.1 | 141.9 | 68 | 196.0 | 182.8 |
| 29 | 21.2 | 19.8 | 89 | 65.1 | 60.7 | 49 | 109.0 | 101.6 | 09 | 152.9 | 142.5 | 69 | 196.7 | 183.5 |
| 30 | 21.9 | 20.5 | 90 | 65.8 | 61.4 | 50 | 109.7 | 102.3 | 10 | 153.6 | 143.2 | 70 | 197.5 | 184.1 |
| 31 | 22.7 | 21.1 | 91 | 66.6 | 62.1 | 151 | 110.4 | 103.0 | 211 | 154.3 | 143.9 | 271 | 198.2 | 184.8 |
| 32 | 23.4 | 21.8 | 92 | 67.3 | 62.7 | 52 | 111.2 | 103.7 | 12 | 155.0 | 144.6 | 72 | 198.9 | 185.5 |
| 33 | 24.1 | 22.5 | 93 | 68.0 | 63.4 | 53 | 111.9 | 104.3 | 13 | 155.8 | 145.3 | 73 | 199.7 | 186.2 |
| 34 | 24.9 | 23.2 | 94 | 68.7 | 64.1 | 54 | 112.6 | 105.0 | 14 | 156.5 | 145.9 | 74 | 200.4 | 186.9 |
| 35 | 25.6 | 23.9 | 95 | 69.5 | 64.8 | 55 | 113.4 | 105.7 | 15 | 157.2 | 146.6 | 75 | 201.1 | 187.5 |
| 36 | 26.3 | 24.6 | 96 | 70.2 | 65.5 | 56 | 114.1 | 106.4 | 16 | 158.0 | 147.3 | 76 | 201.9 | 188.2 |
| 37 | 27.1 | 25.2 | 97 | 70.9 | 66.2 | 57 | 114.8 | 107.1 | 17 | 158.7 | 148.0 | 77 | 202.6 | 188.9 |
| 38 | 27.8 | 25.9 | 98 | 71.7 | 66.8 | 58 | 115.6 | 107.8 | 18 | 159.4 | 148.7 | 78 | 203.3 | 189.6 |
| 39 | 28.5 | 26.6 | 99 | 72.4 | 67.5 | 59 | 116.3 | 108.4 | 19 | 160.2 | 149.4 | 79 | 204.0 | 190.3 |
| 40 | 29.3 | 27.3 | 100 | 73.1 | 68.2 | 60 | 117.0 | 109.1 | 20 | 160.9 | 150.0 | 80 | 204.8 | 191.0 |
| 41 | 30.0 | 28.0 | 101 | 73.9 | 68.9 | 161 | 117.7 | 109.8 | 221 | 161.6 | 150.7 | 281 | 205.5 | 191.6 |
| 42 | 30.7 | 28.6 | 02 | 74.6 | 69.6 | 62 | 118.5 | 110.5 | 22 | 162.4 | 151.4 | 82 | 206.2 | 192.3 |
| 43 | 31.4 | 29.3 | 03 | 75.3 | 70.2 | 63 | 119.2 | 111.2 | 23 | 163.1 | 152.1 | 83 | 207.0 | 193.0 |
| 44 | 32.2 | 30.0 | 04 | 76.1 | 70.9 | 64 | 119.9 | 111.8 | 24 | 163.8 | 152.8 | 84 | 207.7 | 193.7 |
| 45 | 32.9 | 30.7 | 05 | 76.8 | 71.6 | 65 | 120.7 | 112.5 | 25 | 164.6 | 153.4 | 85 | 208.4 | 194.4 |
| 46 | 33.6 | 31.4 | 06 | 77.5 | 72.3 | 66 | 121.4 | 113.2 | 26 | 165.3 | 154.1 | 86 | 209.2 | 195.1 |
| 47 | 34.4 | 32.1 | 07 | 78.3 | 73.0 | 67 | 122.1 | 113.9 | 27 | 166.0 | 154.8 | 87 | 209.9 | 195.7 |
| 48 | 35.1 | 32.7 | 08 | 79.0 | 73.7 | 68 | 122.9 | 114.6 | 28 | 166.7 | 155.5 | 88 | 210.6 | 196.4 |
| 49 | 35.8 | 33.4 | 09 | 79.7 | 74.3 | 69 | 123.6 | 115.3 | 29 | 167.5 | 156.2 | 89 | 211.4 | 197.1 |
| 50 | 36.6 | 34.1 | 10 | 80.4 | 75.0 | 70 | 124.3 | 115.9 | 30 | 168.2 | 156.9 | 90 | 212.1 | 197.8 |
| 51 | 37.3 | 34.8 | 111 | 81.2 | 75.7 | 171 | 125.1 | 116.6 | 231 | 168.9 | 157.5 | 291 | 212.8 | 198.5 |
| 52 | 38.0 | 35.5 | 12 | 81.9 | 76.4 | 72 | 125.8 | 117.3 | 32 | 169.7 | 158.2 | 92 | 213.6 | 199.1 |
| 53 | 38.8 | 36.1 | 13 | 82.6 | 77.1 | 73 | 126.5 | 118.0 | 33 | 170.4 | 158.9 | 93 | 214.3 | 199.8 |
| 54 | 39.5 | 36.8 | 14 | 83.4 | 77.7 | 74 | 127.3 | 118.7 | 34 | 171.1 | 159.6 | 94 | 215.0 | 200.5 |
| 55 | 40.2 | 37.5 | 15 | 84.1 | 78.4 | 75 | 128.0 | 119.3 | 35 | 171.9 | 160.3 | 95 | 215.7 | 201.2 |
| 56 | 41.0 | 38.2 | 16 | 84.8 | 79.1 | 76 | 128.7 | 120.0 | 36 | 172.6 | 161.0 | 96 | 216.5 | 201.9 |
| 57 | 41.7 | 38.9 | 17 | 85.6 | 79.8 | 77 | 129.4 | 120.7 | 37 | 173.3 | 161.6 | 97 | 217.2 | 202.6 |
| 58 | 42.4 | 39.6 | 18 | 86.3 | 80.5 | 78 | 130.2 | 121.4 | 38 | 174.1 | 162.3 | 98 | 217.9 | 203.2 |
| 59 | 43.1 | 40.2 | 19 | 87.0 | 81.2 | 79 | 130.9 | 122.1 | 39 | 174.8 | 163.0 | 99 | 218.7 | 203.9 |
| 60 | 43.9 | 40.9 | 20 | 87.8 | 81.8 | 80 | 131.6 | 122.8 | 40 | 175.5 | 163.7 | 300 | 219.4 | 204.6 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

47° (133°, 227°, 313°).

TABLE 2. [Page 453

## Difference of Latitude and Departure for 43° (137°, 223°, 317°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 220.1 | 205.3 | 361 | 264.0 | 246.2 | 421 | 307.9 | 287.1 | 481 | 351.8 | 328.1 | 541 | 395.7 | 369.0 |
| 02 | 220.9 | 206.0 | 62 | 264.8 | 246.9 | 22 | 308.6 | 287.8 | 82 | 352.5 | 328.7 | 42 | 396.4 | 369.7 |
| 03 | 221.6 | 206.7 | 63 | 265.5 | 247.6 | 23 | 309.4 | 288.5 | 83 | 353.2 | 329.4 | 43 | 397.1 | 370.3 |
| 04 | 222.3 | 207.3 | 64 | 266.2 | 248.3 | 24 | 310.1 | 289.2 | 84 | 354.0 | 330.1 | 44 | 397.9 | 371.0 |
| 05 | 223.1 | 208.0 | 65 | 267.0 | 248.9 | 25 | 310.8 | 289.9 | 85 | 354.7 | 330.8 | 45 | 398.6 | 371.7 |
| 06 | 223.8 | 208.7 | 66 | 267.7 | 249.6 | 26 | 311.6 | 290.5 | 86 | 355.4 | 331.4 | 46 | 399.3 | 372.4 |
| 07 | 224.5 | 209.4 | 67 | 268.4 | 250.3 | 27 | 312.3 | 291.2 | 87 | 356.2 | 332.1 | 47 | 400.1 | 373.1 |
| 08 | 225.3 | 210.1 | 68 | 269.1 | 251.0 | 28 | 313.0 | 291.9 | 88 | 356.9 | 332.8 | 48 | 400.8 | 373.7 |
| 09 | 226.0 | 210.7 | 69 | 269.9 | 251.7 | 29 | 313.8 | 292.6 | 89 | 357.7 | 333.5 | 49 | 401.5 | 374.4 |
| 10 | 226.7 | 211.4 | 70 | 270.6 | 252.3 | 30 | 314.5 | 293.3 | 90 | 358.4 | 334.2 | 50 | 402.2 | 375.1 |
| 311 | 227.5 | 212.1 | 371 | 271.3 | 253.0 | 431 | 315.2 | 293.9 | 491 | 359.1 | 334.9 | 551 | 403.0 | 375.8 |
| 12 | 228.2 | 212.8 | 72 | 272.1 | 253.7 | 32 | 316.0 | 294.6 | 92 | 359.8 | 335.5 | 52 | 403.7 | 376.5 |
| 13 | 228.9 | 213.5 | 73 | 272.8 | 254.4 | 33 | 316.7 | 295.3 | 93 | 360.6 | 336.2 | 53 | 404.4 | 377.1 |
| 14 | 229.7 | 214.2 | 74 | 273.5 | 255.1 | 34 | 317.4 | 296.0 | 94 | 361.3 | 336.9 | 54 | 405.2 | 377.8 |
| 15 | 230.4 | 214.8 | 75 | 274.3 | 255.8 | 35 | 318.1 | 296.7 | 95 | 362.0 | 337.6 | 55 | 405.9 | 378.5 |
| 16 | 231.1 | 215.5 | 76 | 275.0 | 256.4 | 36 | 318.9 | 297.4 | 96 | 362.8 | 338.3 | 56 | 406.6 | 379.2 |
| 17 | 231.8 | 216.2 | 77 | 275.7 | 257.1 | 37 | 319.6 | 298.0 | 97 | 363.5 | 338.9 | 57 | 407.4 | 379.9 |
| 18 | 232.6 | 216.9 | 78 | 276.5 | 257.8 | 38 | 320.3 | 298.7 | 98 | 364.2 | 339.6 | 58 | 408.1 | 380.6 |
| 19 | 233.3 | 217.6 | 79 | 277.2 | 258.5 | 39 | 321.1 | 299.4 | 99 | 364.9 | 340.3 | 59 | 408.8 | 381.2 |
| 20 | 234.0 | 218.2 | 80 | 277.9 | 259.2 | 40 | 321.8 | 300.1 | 500 | 365.7 | 341.0 | 60 | 409.6 | 381.9 |
| 321 | 234.8 | 218.9 | 381 | 278.7 | 259.8 | 441 | 322.5 | 300.8 | 501 | 366.4 | 341.7 | 561 | 410.3 | 382.6 |
| 22 | 235.5 | 219.6 | 82 | 279.4 | 260.5 | 42 | 323.3 | 301.4 | 02 | 367.1 | 342.4 | 62 | 411.0 | 383.3 |
| 23 | 236.2 | 220.3 | 83 | 280.1 | 261.2 | 43 | 324.0 | 302.1 | 03 | 367.8 | 343.0 | 63 | 411.8 | 384.0 |
| 24 | 237.0 | 221.0 | 84 | 280.8 | 261.9 | 44 | 324.7 | 302.8 | 04 | 368.6 | 343.7 | 64 | 412.5 | 384.6 |
| 25 | 237.7 | 221.7 | 85 | 281.6 | 262.6 | 45 | 325.5 | 303.5 | 05 | 369.3 | 344.4 | 65 | 413.2 | 385.3 |
| 26 | 238.4 | 222.3 | 86 | 282.3 | 263.3 | 46 | 326.2 | 304.2 | 06 | 370.0 | 345.1 | 66 | 414.0 | 386.0 |
| 27 | 239.2 | 223.0 | 87 | 283.0 | 263.9 | 47 | 326.9 | 304.9 | 07 | 370.8 | 345.8 | 67 | 414.7 | 386.7 |
| 28 | 239.9 | 223.7 | 88 | 283.7 | 264.6 | 48 | 327.7 | 305.5 | 08 | 371.5 | 346.5 | 68 | 415.4 | 387.4 |
| 29 | 240.6 | 224.4 | 89 | 284.5 | 265.3 | 49 | 328.4 | 306.2 | 09 | 372.3 | 347.1 | 69 | 416.2 | 388.1 |
| 30 | 241.4 | 225.1 | 90 | 285.2 | 266.0 | 50 | 329.1 | 306.9 | 10 | 373.0 | 347.8 | 70 | 416.9 | 388.7 |
| 331 | 242.1 | 225.7 | 391 | 286.0 | 266.7 | 451 | 329.9 | 307.6 | 511 | 373.8 | 348.5 | 571 | 417.6 | 389.4 |
| 32 | 242.8 | 226.4 | 92 | 286.7 | 267.3 | 52 | 330.6 | 308.3 | 12 | 374.5 | 349.2 | 72 | 418.3 | 390.1 |
| 33 | 243.5 | 227.1 | 93 | 287.4 | 268.0 | 53 | 331.3 | 309.0 | 13 | 375.2 | 349.9 | 73 | 419.1 | 390.8 |
| 34 | 244.3 | 227.8 | 94 | 288.2 | 268.7 | 54 | 332.1 | 309.6 | 14 | 376.0 | 350.5 | 74 | 419.8 | 391.5 |
| 35 | 245.0 | 228.5 | 95 | 288.9 | 269.4 | 55 | 332.8 | 310.3 | 15 | 376.6 | 351.2 | 75 | 420.5 | 392.2 |
| 36 | 245.7 | 229.2 | 96 | 289.6 | 270.1 | 56 | 333.5 | 311.0 | 16 | 377.4 | 351.9 | 76 | 421.3 | 392.8 |
| 37 | 246.5 | 229.8 | 97 | 290.4 | 270.8 | 57 | 334.3 | 311.7 | 17 | 378.2 | 352.6 | 77 | 422.0 | 393.5 |
| 38 | 247.2 | 230.5 | 98 | 291.1 | 271.4 | 58 | 335.0 | 312.4 | 18 | 378.9 | 353.3 | 78 | 422.7 | 394.2 |
| 39 | 247.9 | 231.2 | 99 | 291.8 | 272.1 | 59 | 335.7 | 313.0 | 19 | 379.6 | 354.0 | 79 | 423.5 | 394.9 |
| 40 | 248.7 | 231.9 | 400 | 292.6 | 272.8 | 60 | 336.5 | 313.7 | 20 | 380.3 | 354.6 | 80 | 424.2 | 395.6 |
| 341 | 249.4 | 232.6 | 401 | 293.3 | 273.5 | 461 | 337.2 | 314.4 | 521 | 381.1 | 355.3 | 581 | 424.9 | 396.2 |
| 42 | 250.1 | 233.2 | 02 | 294.0 | 274.2 | 62 | 337.9 | 315.1 | 22 | 381.8 | 356.0 | 82 | 425.7 | 396.9 |
| 43 | 250.9 | 233.9 | 03 | 294.7 | 274.9 | 63 | 338.7 | 315.8 | 23 | 382.6 | 356.7 | 83 | 426.4 | 397.6 |
| 44 | 251.6 | 234.6 | 04 | 295.5 | 275.5 | 64 | 339.4 | 316.5 | 24 | 383.3 | 357.4 | 84 | 427.1 | 398.3 |
| 45 | 252.3 | 235.3 | 05 | 296.2 | 276.2 | 65 | 340.1 | 317.1 | 25 | 384.0 | 358.1 | 85 | 427.9 | 399.0 |
| 46 | 253.1 | 236.0 | 06 | 296.9 | 276.9 | 66 | 340.8 | 317.8 | 26 | 384.7 | 358.7 | 86 | 428.6 | 399.6 |
| 47 | 253.8 | 236.7 | 07 | 297.7 | 277.6 | 67 | 341.6 | 318.5 | 27 | 385.5 | 359.4 | 87 | 429.3 | 400.3 |
| 48 | 254.5 | 237.3 | 08 | 298.4 | 278.3 | 68 | 342.3 | 319.2 | 28 | 386.2 | 360.1 | 88 | 430.1 | 401.0 |
| 49 | 255.3 | 238.0 | 09 | 299.1 | 278.9 | 69 | 343.0 | 319.9 | 29 | 386.9 | 360.8 | 89 | 430.8 | 401.7 |
| 50 | 256.0 | 238.7 | 10 | 299.9 | 279.6 | 70 | 343.7 | 320.5 | 30 | 387.6 | 361.5 | 90 | 431.5 | 402.4 |
| 351 | 256.7 | 239.4 | 411 | 300.6 | 280.3 | 471 | 344.5 | 321.2 | 531 | 388.4 | 362.1 | 591 | 432.3 | 403.1 |
| 52 | 257.4 | 240.1 | 12 | 301.3 | 281.0 | 72 | 345.2 | 321.9 | 32 | 389.1 | 362.8 | 92 | 433.0 | 403.7 |
| 53 | 258.2 | 240.8 | 13 | 302.1 | 281.7 | 73 | 345.9 | 322.6 | 33 | 389.9 | 363.5 | 93 | 433.7 | 404.4 |
| 54 | 258.9 | 241.4 | 14 | 302.8 | 282.4 | 74 | 346.7 | 323.3 | 34 | 390.6 | 364.2 | 94 | 434.5 | 405.1 |
| 55 | 259.6 | 242.1 | 15 | 303.5 | 283.0 | 75 | 347.4 | 324.0 | 35 | 391.3 | 364.9 | 95 | 435.2 | 405.8 |
| 56 | 260.4 | 242.8 | 16 | 304.3 | 283.7 | 76 | 348.1 | 324.6 | 36 | 392.0 | 365.5 | 96 | 435.9 | 406.5 |
| 57 | 261.1 | 243.5 | 17 | 305.0 | 284.4 | 77 | 348.8 | 325.3 | 37 | 392.8 | 366.2 | 97 | 436.7 | 407.2 |
| 58 | 261.8 | 244.2 | 18 | 305.7 | 285.1 | 78 | 349.6 | 326.0 | 38 | 393.5 | 366.9 | 98 | 437.4 | 407.8 |
| 59 | 262.6 | 244.8 | 19 | 306.4 | 285.8 | 79 | 350.3 | 326.7 | 39 | 394.2 | 367.6 | 99 | 438.1 | 408.5 |
| 60 | 263.3 | 245.5 | 20 | 307.2 | 286.4 | 80 | 351.1 | 327.4 | 40 | 394.9 | 368.3 | 600 | 438.8 | 409.2 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

TABLE 2.

Difference of Latitude and Departure for 44° (136°, 224°, 316°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.7 | 61 | 43.9 | 42.4 | 121 | 87.0 | 84.1 | 181 | 130.2 | 125.7 | 241 | 173.4 | 167.4 |
| 2 | 1.4 | 1.4 | 62 | 44.6 | 43.1 | 22 | 87.8 | 84.7 | 82 | 130.9 | 126.4 | 42 | 174.1 | 168.1 |
| 3 | 2.2 | 2.1 | 63 | 45.3 | 43.8 | 23 | 88.5 | 85.4 | 83 | 131.6 | 127.1 | 43 | 174.8 | 168.8 |
| 4 | 2.9 | 2.8 | 64 | 46.0 | 44.5 | 24 | 89.2 | 86.1 | 84 | 132.4 | 127.8 | 44 | 175.5 | 169.5 |
| 5 | 3.6 | 3.5 | 65 | 46.8 | 45.2 | 25 | 89.9 | 86.8 | 85 | 133.1 | 128.5 | 45 | 176.2 | 170.2 |
| 6 | 4.3 | 4.2 | 66 | 47.5 | 45.8 | 26 | 90.6 | 87.5 | 86 | 133.8 | 129.2 | 46 | 177.0 | 170.9 |
| 7 | 5.0 | 4.9 | 67 | 48.2 | 46.5 | 27 | 91.4 | 88.2 | 87 | 134.5 | 129.9 | 47 | 177.7 | 171.6 |
| 8 | 5.8 | 5.6 | 68 | 48.9 | 47.2 | 28 | 92.1 | 88.9 | 88 | 135.2 | 130.6 | 48 | 178.4 | 172.3 |
| 9 | 6.5 | 6.3 | 69 | 49.6 | 47.9 | 29 | 92.8 | 89.6 | 89 | 136.0 | 131.3 | 49 | 179.1 | 173.0 |
| 10 | 7.2 | 6.9 | 70 | 50.4 | 48.6 | 30 | 93.5 | 90.3 | 90 | 136.7 | 132.0 | 50 | 179.8 | 173.7 |
| 11 | 7.9 | 7.6 | 71 | 51.1 | 49.3 | 131 | 94.2 | 91.0 | 191 | 137.4 | 132.7 | 251 | 180.6 | 174.4 |
| 12 | 8.6 | 8.3 | 72 | 51.8 | 50.0 | 32 | 95.0 | 91.7 | 92 | 138.1 | 133.4 | 52 | 181.3 | 175.1 |
| 13 | 9.4 | 9.0 | 73 | 52.5 | 50.7 | 33 | 95.7 | 92.4 | 93 | 138.8 | 134.1 | 53 | 182.0 | 175.7 |
| 14 | 10.1 | 9.7 | 74 | 53.2 | 51.4 | 34 | 96.4 | 93.1 | 94 | 139.6 | 134.8 | 54 | 182.7 | 176.4 |
| 15 | 10.8 | 10.4 | 75 | 54.0 | 52.1 | 35 | 97.1 | 93.8 | 95 | 140.3 | 135.5 | 55 | 183.4 | 177.1 |
| 16 | 11.5 | 11.1 | 76 | 54.7 | 52.8 | 36 | 97.8 | 94.5 | 96 | 141.0 | 136.2 | 56 | 184.2 | 177.8 |
| 17 | 12.2 | 11.8 | 77 | 55.4 | 53.5 | 37 | 98.5 | 95.2 | 97 | 141.7 | 136.8 | 57 | 184.9 | 178.5 |
| 18 | 12.9 | 12.5 | 78 | 56.1 | 54.2 | 38 | 99.3 | 95.9 | 98 | 142.4 | 137.5 | 58 | 185.6 | 179.2 |
| 19 | 13.7 | 13.2 | 79 | 56.8 | 54.9 | 39 | 100.0 | 96.6 | 99 | 143.1 | 138.2 | 59 | 186.3 | 179.9 |
| 20 | 14.4 | 13.9 | 80 | 57.5 | 55.6 | 40 | 100.7 | 97.3 | 200 | 143.9 | 138.9 | 60 | 187.0 | 180.6 |
| 21 | 15.1 | 14.6 | 81 | 58.3 | 56.3 | 141 | 101.4 | 97.9 | 201 | 144.6 | 139.6 | 261 | 187.7 | 181.3 |
| 22 | 15.8 | 15.3 | 82 | 59.0 | 57.0 | 42 | 102.1 | 98.6 | 02 | 145.3 | 140.3 | 62 | 188.5 | 182.0 |
| 23 | 16.5 | 16.0 | 83 | 59.7 | 57.7 | 43 | 102.9 | 99.3 | 03 | 146.0 | 141.0 | 63 | 189.2 | 182.7 |
| 24 | 17.3 | 16.7 | 84 | 60.4 | 58.4 | 44 | 103.6 | 100.0 | 04 | 146.7 | 141.7 | 64 | 189.9 | 183.4 |
| 25 | 18.0 | 17.4 | 85 | 61.1 | 59.0 | 45 | 104.3 | 100.7 | 05 | 147.5 | 142.4 | 65 | 190.6 | 184.1 |
| 26 | 18.7 | 18.1 | 86 | 61.9 | 59.7 | 46 | 105.0 | 101.4 | 06 | 148.2 | 143.1 | 66 | 191.3 | 184.8 |
| 27 | 19.4 | 18.8 | 87 | 62.6 | 60.4 | 47 | 105.7 | 102.1 | 07 | 148.9 | 143.8 | 67 | 192.1 | 185.5 |
| 28 | 20.1 | 19.5 | 88 | 63.3 | 61.1 | 48 | 106.5 | 102.8 | 08 | 149.6 | 144.5 | 68 | 192.8 | 186.2 |
| 29 | 20.9 | 20.1 | 89 | 64.0 | 61.8 | 49 | 107.2 | 103.5 | 09 | 150.3 | 145.2 | 69 | 193.5 | 186.9 |
| 30 | 21.6 | 20.8 | 90 | 64.7 | 62.5 | 50 | 107.9 | 104.2 | 10 | 151.1 | 145.9 | 70 | 194.2 | 187.6 |
| 31 | 22.3 | 21.5 | 91 | 65.5 | 63.2 | 151 | 108.6 | 104.9 | 211 | 151.8 | 146.6 | 271 | 194.9 | 188.3 |
| 32 | 23.0 | 22.2 | 92 | 66.2 | 63.9 | 52 | 109.3 | 105.6 | 12 | 152.5 | 147.3 | 72 | 195.7 | 188.9 |
| 33 | 23.7 | 22.9 | 93 | 66.9 | 64.6 | 53 | 110.1 | 106.3 | 13 | 153.2 | 148.0 | 73 | 196.4 | 189.6 |
| 34 | 24.5 | 23.6 | 94 | 67.6 | 65.3 | 54 | 110.8 | 107.0 | 14 | 153.9 | 148.7 | 74 | 197.1 | 190.3 |
| 35 | 25.2 | 24.3 | 95 | 68.3 | 66.0 | 55 | 111.5 | 107.7 | 15 | 154.7 | 149.4 | 75 | 197.8 | 191.0 |
| 36 | 25.9 | 25.0 | 96 | 69.1 | 66.7 | 56 | 112.2 | 108.4 | 16 | 155.4 | 150.0 | 76 | 198.5 | 191.7 |
| 37 | 26.6 | 25.7 | 97 | 69.8 | 67.4 | 57 | 112.9 | 109.1 | 17 | 156.1 | 150.7 | 77 | 199.3 | 192.4 |
| 38 | 27.3 | 26.4 | 98 | 70.5 | 68.1 | 58 | 113.7 | 109.8 | 18 | 156.8 | 151.4 | 78 | 200.0 | 193.1 |
| 39 | 28.1 | 27.1 | 99 | 71.2 | 68.8 | 59 | 114.4 | 110.5 | 19 | 157.5 | 152.1 | 79 | 200.7 | 193.8 |
| 40 | 28.8 | 27.8 | 100 | 71.9 | 69.5 | 60 | 115.1 | 111.1 | 20 | 158.3 | 152.8 | 80 | 201.4 | 194.5 |
| 41 | 29.5 | 28.5 | 101 | 72.7 | 70.2 | 161 | 115.8 | 111.8 | 221 | 159.0 | 153.5 | 281 | 202.1 | 195.2 |
| 42 | 30.2 | 29.2 | 02 | 73.4 | 70.9 | 62 | 116.5 | 112.5 | 22 | 159.7 | 154.2 | 82 | 202.9 | 195.9 |
| 43 | 30.9 | 29.9 | 03 | 74.1 | 71.5 | 63 | 117.3 | 113.2 | 23 | 160.4 | 154.9 | 83 | 203.6 | 196.6 |
| 44 | 31.7 | 30.6 | 04 | 74.8 | 72.2 | 64 | 118.0 | 113.9 | 24 | 161.1 | 155.6 | 84 | 204.3 | 197.3 |
| 45 | 32.4 | 31.3 | 05 | 75.5 | 72.9 | 65 | 118.7 | 114.6 | 25 | 161.9 | 156.3 | 85 | 205.0 | 198.0 |
| 46 | 33.1 | 32.0 | 06 | 76.3 | 73.6 | 66 | 119.4 | 115.3 | 26 | 162.6 | 157.0 | 86 | 205.7 | 198.7 |
| 47 | 33.8 | 32.6 | 07 | 77.0 | 74.3 | 67 | 120.1 | 116.0 | 27 | 163.3 | 157.7 | 87 | 206.5 | 199.4 |
| 48 | 34.5 | 33.3 | 08 | 77.7 | 75.0 | 68 | 120.8 | 116.7 | 28 | 164.0 | 158.4 | 88 | 207.2 | 200.1 |
| 49 | 35.2 | 34.0 | 09 | 78.4 | 75.7 | 69 | 121.6 | 117.4 | 29 | 164.7 | 159.1 | 89 | 207.9 | 200.8 |
| 50 | 36.0 | 34.7 | 10 | 79.1 | 76.4 | 70 | 122.3 | 118.1 | 30 | 165.4 | 159.8 | 90 | 208.6 | 201.5 |
| 51 | 36.7 | 35.4 | 111 | 79.8 | 77.1 | 171 | 123.0 | 118.8 | 231 | 166.2 | 160.5 | 291 | 209.3 | 202.1 |
| 52 | 37.4 | 36.1 | 12 | 80.6 | 77.8 | 72 | 123.7 | 119.5 | 32 | 166.9 | 161.2 | 92 | 210.0 | 202.8 |
| 53 | 38.1 | 36.8 | 13 | 81.3 | 78.5 | 73 | 124.4 | 120.2 | 33 | 167.6 | 161.9 | 93 | 210.8 | 203.5 |
| 54 | 38.8 | 37.5 | 14 | 82.0 | 79.2 | 74 | 125.2 | 120.9 | 34 | 168.3 | 162.6 | 94 | 211.5 | 204.2 |
| 55 | 39.6 | 38.2 | 15 | 82.7 | 79.9 | 75 | 125.9 | 121.6 | 35 | 169.0 | 163.2 | 95 | 212.2 | 204.9 |
| 56 | 40.3 | 38.9 | 16 | 83.4 | 80.6 | 76 | 126.6 | 122.3 | 36 | 169.8 | 163.9 | 96 | 212.9 | 205.6 |
| 57 | 41.0 | 39.6 | 17 | 84.2 | 81.3 | 77 | 127.3 | 123.0 | 37 | 170.5 | 164.6 | 97 | 213.6 | 206.3 |
| 58 | 41.7 | 40.3 | 18 | 84.9 | 82.0 | 78 | 128.0 | 123.6 | 38 | 171.2 | 165.3 | 98 | 214.4 | 207.0 |
| 59 | 42.4 | 41.0 | 19 | 85.6 | 82.7 | 79 | 128.8 | 124.3 | 39 | 171.9 | 166.0 | 99 | 215.1 | 207.7 |
| 60 | 43.2 | 41.7 | 20 | 86.3 | 83.4 | 80 | 129.5 | 125.0 | 40 | 172.6 | 166.7 | 300 | 215.8 | 208.4 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

46° (134°, 226°, 314°).

TABLE 2. [Page 455

Difference of Latitude and Departure for 44° (136°, 224°, 316°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 216.5 | 209.1 | 361 | 259.7 | 250.8 | 421 | 302.8 | 292.5 | 481 | 346.0 | 334.1 | 541 | 389.2 | 375.8 |
| 02 | 217.2 | 209.8 | 62 | 260.4 | 251.5 | 22 | 303.6 | 293.2 | 82 | 346.7 | 334.8 | 42 | 389.9 | 376.5 |
| 03 | 218.0 | 210.5 | 63 | 261.1 | 252.2 | 23 | 304.3 | 293.8 | 83 | 347.4 | 335.5 | 43 | 390.6 | 377.2 |
| 04 | 218.7 | 211.2 | 64 | 261.8 | 252.9 | 24 | 305.0 | 294.5 | 84 | 348.2 | 336.2 | 44 | 391.3 | 377.9 |
| 05 | 219.4 | 211.9 | 65 | 262.6 | 253.6 | 25 | 305.7 | 295.2 | 85 | 348.9 | 336.9 | 45 | 392.0 | 378.6 |
| 06 | 220.1 | 212.6 | 66 | 263.3 | 254.3 | 26 | 306.4 | 295.9 | 86 | 349.6 | 337.6 | 46 | 392.8 | 379.3 |
| 07 | 220.8 | 213.3 | 67 | 264.0 | 254.9 | 27 | 307.2 | 296.6 | 87 | 350.3 | 338.3 | 47 | 393.5 | 380.0 |
| 08 | 221.6 | 214.0 | 68 | 264.7 | 255.6 | 28 | 307.9 | 297.3 | 88 | 351.0 | 339.0 | 48 | 394.2 | 380.7 |
| 09 | 222.3 | 214.7 | 69 | 265.4 | 256.3 | 29 | 308.6 | 298.0 | 89 | 351.7 | 339.7 | 49 | 394.9 | 381.4 |
| 10 | 223.0 | 215.4 | 70 | 266.2 | 257.0 | 30 | 309.3 | 298.7 | 90 | 352.5 | 340.4 | 50 | 395.6 | 382.1 |
| 311 | 223.7 | 216.0 | 371 | 266.9 | 257.7 | 431 | 310.0 | 299.4 | 491 | 353.2 | 341.1 | 551 | 396.4 | 382.7 |
| 12 | 224.4 | 216.7 | 72 | 267.6 | 258.4 | 32 | 310.8 | 300.1 | 92 | 353.9 | 341.8 | 52 | 397.1 | 383.4 |
| 13 | 225.2 | 217.4 | 73 | 268.3 | 259.1 | 33 | 311.5 | 300.8 | 93 | 354.6 | 342.5 | 53 | 397.8 | 384.1 |
| 14 | 225.9 | 218.1 | 74 | 269.0 | 259.8 | 34 | 312.2 | 301.5 | 94 | 355.3 | 343.2 | 54 | 398.5 | 384.8 |
| 15 | 226.6 | 218.8 | 75 | 269.8 | 260.5 | 35 | 312.9 | 302.2 | 95 | 356.1 | 343.9 | 55 | 399.2 | 385.5 |
| 16 | 227.3 | 219.5 | 76 | 270.5 | 261.2 | 36 | 313.6 | 302.9 | 96 | 356.8 | 344.6 | 56 | 400.0 | 386.2 |
| 17 | 228.0 | 220.2 | 77 | 271.2 | 261.9 | 37 | 314.4 | 303.6 | 97 | 357.5 | 345.2 | 57 | 400.7 | 386.9 |
| 18 | 228.8 | 220.9 | 78 | 271.9 | 262.6 | 38 | 315.1 | 304.3 | 98 | 358.2 | 345.9 | 58 | 401.4 | 387.6 |
| 19 | 229.5 | 221.6 | 79 | 272.6 | 263.3 | 39 | 315.8 | 305.0 | 99 | 358.9 | 346.6 | 59 | 402.1 | 388.3 |
| 20 | 230.2 | 222.3 | 80 | 273.4 | 264.0 | 40 | 316.5 | 305.7 | 500 | 359.7 | 347.3 | 60 | 402.8 | 389.0 |
| 321 | 230.9 | 223.0 | 381 | 274.1 | 264.7 | 441 | 317.2 | 306.4 | 501 | 360.4 | 348.0 | 561 | 403.6 | 389.7 |
| 22 | 231.6 | 223.7 | 82 | 274.8 | 265.4 | 42 | 318.0 | 307.0 | 02 | 361.1 | 348.7 | 62 | 404.3 | 390.4 |
| 23 | 232.3 | 224.4 | 83 | 275.5 | 266.1 | 43 | 318.7 | 307.7 | 03 | 361.8 | 349.4 | 63 | 405.0 | 391.1 |
| 24 | 233.1 | 225.1 | 84 | 276.2 | 266.8 | 44 | 319.4 | 308.4 | 04 | 362.5 | 350.1 | 64 | 405.7 | 391.8 |
| 25 | 233.8 | 225.8 | 85 | 276.9 | 267.5 | 45 | 320.1 | 309.1 | 05 | 363.3 | 350.8 | 65 | 406.4 | 392.5 |
| 26 | 234.5 | 226.5 | 86 | 277.7 | 268.1 | 46 | 320.8 | 309.8 | 06 | 364.0 | 351.5 | 66 | 407.2 | 393.2 |
| 27 | 235.2 | 227.2 | 87 | 278.4 | 268.8 | 47 | 321.5 | 310.5 | 07 | 364.7 | 352.2 | 67 | 407.9 | 393.9 |
| 28 | 235.9 | 227.9 | 88 | 279.1 | 269.5 | 48 | 322.3 | 311.2 | 08 | 365.4 | 352.9 | 68 | 408.6 | 394.6 |
| 29 | 236.7 | 228.6 | 89 | 279.8 | 270.2 | 49 | 323.0 | 311.9 | 09 | 366.1 | 353.6 | 69 | 409.3 | 395.3 |
| 30 | 237.4 | 229.2 | 90 | 280.5 | 270.9 | 50 | 323.7 | 312.6 | 10 | 366.9 | 354.3 | 70 | 410.0 | 396.0 |
| 331 | 238.1 | 229.9 | 391 | 281.3 | 271.6 | 451 | 324.4 | 313.3 | 511 | 367.6 | 355.0 | 571 | 410.7 | 396.7 |
| 32 | 238.8 | 230.6 | 92 | 282.0 | 272.3 | 52 | 325.2 | 314.0 | 12 | 368.3 | 355.7 | 72 | 411.5 | 397.3 |
| 33 | 239.5 | 231.3 | 93 | 282.7 | 273.0 | 53 | 325.9 | 314.7 | 13 | 369.0 | 356.4 | 73 | 412.2 | 398.0 |
| 34 | 240.3 | 232.0 | 94 | 283.4 | 273.7 | 54 | 326.6 | 315.4 | 14 | 369.7 | 357.1 | 74 | 412.9 | 398.7 |
| 35 | 241.0 | 232.7 | 95 | 284.1 | 274.4 | 55 | 327.3 | 316.1 | 15 | 370.5 | 357.8 | 75 | 413.6 | 399.4 |
| 36 | 241.7 | 233.4 | 96 | 284.9 | 275.1 | 56 | 328.0 | 316.8 | 16 | 371.2 | 358.4 | 76 | 414.3 | 400.1 |
| 37 | 242.4 | 234.1 | 97 | 285.6 | 275.8 | 57 | 328.7 | 317.5 | 17 | 371.9 | 359.1 | 77 | 415.1 | 400.8 |
| 38 | 243.1 | 234.8 | 98 | 286.3 | 276.5 | 58 | 329.5 | 318.2 | 18 | 372.6 | 359.8 | 78 | 415.8 | 401.5 |
| 39 | 243.9 | 235.5 | 99 | 287.0 | 277.2 | 59 | 330.2 | 318.9 | 19 | 373.3 | 360.5 | 79 | 416.5 | 402.2 |
| 40 | 244.6 | 236.2 | 400 | 287.7 | 277.9 | 60 | 330.9 | 319.6 | 20 | 374.1 | 361.2 | 80 | 417.2 | 402.9 |
| 341 | 245.3 | 236.9 | 401 | 288.5 | 278.6 | 461 | 331.6 | 320.2 | 521 | 374.8 | 361.9 | 581 | 417.9 | 403.6 |
| 42 | 246.0 | 237.6 | 02 | 289.2 | 279.3 | 62 | 332.3 | 320.9 | 22 | 375.5 | 362.6 | 82 | 418.7 | 404.3 |
| 43 | 246.7 | 238.3 | 03 | 289.9 | 280.0 | 63 | 333.1 | 321.6 | 23 | 376.2 | 363.3 | 83 | 419.4 | 405.0 |
| 44 | 247.5 | 239.0 | 04 | 290.6 | 280.7 | 64 | 333.8 | 322.3 | 24 | 376.9 | 364.0 | 84 | 420.1 | 405.7 |
| 45 | 248.2 | 239.7 | 05 | 291.3 | 281.3 | 65 | 334.5 | 323.0 | 25 | 377.7 | 364.7 | 85 | 420.8 | 406.4 |
| 46 | 248.9 | 240.4 | 06 | 292.1 | 282.0 | 66 | 335.2 | 323.7 | 26 | 378.4 | 365.4 | 86 | 421.5 | 407.1 |
| 47 | 249.6 | 241.1 | 07 | 292.8 | 282.7 | 67 | 335.9 | 324.4 | 27 | 379.1 | 366.1 | 87 | 422.3 | 407.8 |
| 48 | 250.3 | 241.7 | 08 | 293.5 | 283.4 | 68 | 336.7 | 325.1 | 28 | 379.8 | 366.8 | 88 | 423.0 | 408.5 |
| 49 | 251.1 | 242.4 | 09 | 294.2 | 284.1 | 69 | 337.4 | 325.8 | 29 | 380.5 | 367.5 | 89 | 423.7 | 409.1 |
| 50 | 251.8 | 243.1 | 10 | 294.9 | 284.8 | 70 | 338.1 | 326.5 | 30 | 381.2 | 368.2 | 90 | 424.4 | 409.9 |
| 351 | 252.5 | 243.8 | 411 | 295.7 | 285.5 | 471 | 338.8 | 327.2 | 531 | 382.0 | 368.9 | 591 | 425.1 | 410.5 |
| 52 | 253.2 | 244.5 | 12 | 296.4 | 286.2 | 72 | 339.5 | 327.9 | 32 | 382.7 | 369.6 | 92 | 425.9 | 411.2 |
| 53 | 253.9 | 245.2 | 13 | 297.1 | 286.9 | 73 | 340.3 | 328.6 | 33 | 383.4 | 370.3 | 93 | 426.6 | 411.9 |
| 54 | 254.6 | 245.9 | 14 | 297.8 | 287.6 | 74 | 341.0 | 329.3 | 34 | 384.1 | 371.0 | 94 | 427.3 | 412.6 |
| 55 | 255.4 | 246.6 | 15 | 298.5 | 288.3 | 75 | 341.7 | 330.0 | 35 | 384.8 | 371.7 | 95 | 428.0 | 413.3 |
| 56 | 256.1 | 247.3 | 16 | 299.2 | 289.0 | 76 | 342.4 | 330.7 | 36 | 385.6 | 372.4 | 96 | 428.7 | 414.0 |
| 57 | 256.8 | 248.0 | 17 | 300.0 | 289.7 | 77 | 343.1 | 331.4 | 37 | 386.3 | 373.1 | 97 | 429.5 | 414.7 |
| 58 | 257.5 | 248.7 | 18 | 300.7 | 290.4 | 78 | 343.8 | 332.1 | 38 | 387.0 | 373.7 | 98 | 430.2 | 415.4 |
| 59 | 258.2 | 249.4 | 19 | 301.4 | 291.1 | 79 | 344.6 | 332.7 | 39 | 387.7 | 374.4 | 99 | 430.9 | 416.1 |
| 60 | 259.0 | 250.1 | 20 | 302.1 | 291.8 | 80 | 345.3 | 333.4 | 40 | 388.4 | 375.1 | 600 | 431.6 | 416.8 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

46° (134°, 226°, 314°).

TABLE 2.

Difference of Latitude and Departure for 45° (135°, 225°, 315°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.7 | 61 | 43.1 | 43.1 | 121 | 85.6 | 85.6 | 181 | 128.0 | 128.0 | 241 | 170.4 | 170.4 |
| 2 | 1.4 | 1.4 | 62 | 43.8 | 43.8 | 22 | 86.3 | 86.3 | 82 | 128.7 | 128.7 | 42 | 171.1 | 171.1 |
| 3 | 2.1 | 2.1 | 63 | 44.5 | 44.5 | 23 | 87.0 | 87.0 | 83 | 129.4 | 129.4 | 43 | 171.8 | 171.8 |
| 4 | 2.8 | 2.8 | 64 | 45.3 | 45.3 | 24 | 87.7 | 87.7 | 84 | 130.1 | 130.1 | 44 | 172.5 | 172.5 |
| 5 | 3.5 | 3.5 | 65 | 46.0 | 46.0 | 25 | 88.4 | 88.4 | 85 | 130.8 | 130.8 | 45 | 173.2 | 173.2 |
| 6 | 4.2 | 4.2 | 66 | 46.7 | 46.7 | 26 | 89.1 | 89.1 | 86 | 131.5 | 131.5 | 46 | 173.9 | 173.9 |
| 7 | 4.9 | 4.9 | 67 | 47.4 | 47.4 | 27 | 89.8 | 89.8 | 87 | 132.2 | 132.2 | 47 | 174.7 | 174.7 |
| 8 | 5.7 | 5.7 | 68 | 48.1 | 48.1 | 28 | 90.5 | 90.5 | 88 | 132.9 | 132.9 | 48 | 175.4 | 175.4 |
| 9 | 6.4 | 6.4 | 69 | 48.8 | 48.8 | 29 | 91.2 | 91.2 | 89 | 133.6 | 133.6 | 49 | 176.1 | 176.1 |
| 10 | 7.1 | 7.1 | 70 | 49.5 | 49.5 | 30 | 91.9 | 91.9 | 90 | 134.4 | 134.4 | 50 | 176.8 | 176.8 |
| 11 | 7.8 | 7.8 | 71 | 50.2 | 50.2 | 131 | 92.6 | 92.6 | 191 | 135.1 | 135.1 | 251 | 177.5 | 177.5 |
| 12 | 8.5 | 8.5 | 72 | 50.9 | 50.9 | 32 | 93.3 | 93.3 | 92 | 135.8 | 135.8 | 52 | 178.2 | 178.2 |
| 13 | 9.2 | 9.2 | 73 | ·51.6 | 51.6 | 33 | 94.0 | 94.0 | 93 | 136.5 | 136.5 | 53 | 178.9 | 178.9 |
| 14 | 9.9 | 9.9 | 74 | 52.3 | 52.3 | 34 | 94.8 | 94.8 | 94 | 137.2 | 137.2 | 54 | 179.6 | 179.6 |
| 15 | 10.6 | 10.6 | 75 | 53.0 | 53.0 | 35 | 95.5 | 95.5 | 95 | 137.9 | 137.9 | 55 | 180.3 | 180.3 |
| 16 | 11.3 | 11.3 | 76 | 53.7 | 53.7 | 36 | 96.2 | 96.2 | 96 | 138.6 | 138.6 | 56 | 181.0 | 181.0 |
| 17 | 12.0 | 12.0 | 77 | 54.4 | 54.4 | 37 | 96.9 | 96.9 | 97 | 139.3 | 139.3 | 57 | 181.7 | 181.7 |
| 18 | 12.7 | 12.7 | 78 | 55.2 | 55.2 | 38 | 97.6 | 97.6 | 98 | 140.0 | 140.0 | 58 | 182.4 | 182.4 |
| 19 | 13.4 | 13.4 | 79 | 55.9 | 55.9 | 39 | 98.3 | 98.3 | 99 | 140.7 | 140.7 | 59 | 183.1 | 183.1 |
| 20 | 14.1 | 14.1 | 80 | 56.6 | 56.6 | 40 | 99.0 | 99.0 | 200 | 141.4 | 141.4 | 60 | 183.8 | 183.8 |
| 21 | 14.8 | 14.8 | 81 | 57.3 | 57.3 | 141 | 99.7 | 99.7 | 201 | 142.1 | 142.1 | 261 | 184.6 | 184.6 |
| 22 | 15.6 | 15.6 | 82 | 58.0 | 58.0 | 42 | 100.4 | 100.4 | 02 | 142.8 | 142.8 | 62 | 185.3 | 185.3 |
| 23 | 16.3 | 16.3 | 83 | 58.7 | 58.7 | 43 | 101.1 | 101.1 | 03 | 143.5 | 143.5 | 63 | 186.0 | 186.0 |
| 24 | 17.0 | 17.0 | 84 | 59.4 | 59.4 | 44 | 101.8 | 101.8 | 04 | 144.2 | 144.2 | 64 | 186.7 | 186.7 |
| 25 | 17.7 | 17.7 | 85 | 60.1 | 60.1 | 45 | 102.5 | 102.5 | 05 | 145.0 | 145.0 | 65 | 187.4 | 187.4 |
| 26 | 18.4 | 18.4 | 86 | 60.8 | 60.8 | 46 | 103.2 | 103.2 | 06 | 145.7 | 145.7 | 66 | 188.1 | 188.1 |
| 27 | 19.1 | 19.1 | 87 | 61.5 | 61.5 | 47 | 103.9 | 103.9 | 07 | 146.4 | 146.4 | 67 | 188.8 | 188.8 |
| 28 | 19.8 | 19.8 | 88 | 62.2 | 62.2 | 48 | 104.7 | 104.7 | 08 | 147.1 | 147.1 | 68 | 189.5 | 189.5 |
| 29 | 20.5 | 20.5 | 89 | 62.9 | 62.9 | 49 | 105.4 | 105.4 | 09 | 147.8 | 147.8 | 69 | 190.2 | 190.2 |
| 30 | 21.2 | 21.2 | 90 | 63.6 | 63.6 | 50 | 106.1 | 106.1 | 10 | 148.5 | 148.5 | 70 | 190.9 | 190.9 |
| 31 | 21.9 | 21.9 | 91 | 64.3 | 64.3 | 151 | 106.8 | 106.8 | 211 | 149.2 | 149.2 | 271 | 191.6 | 191.6 |
| 32 | 22.6 | 22.6 | 92 | 65.1 | 65.1 | 52 | 107.5 | 107.5 | 12 | 149.9 | 149.9 | ·72 | 192.3 | 192.3 |
| 33 | 23.3 | 23.3 | 93 | 65.8 | 65.8 | 53 | 108.2 | 108.2 | 13 | 150.6 | 150.6 | 73 | 193.0 | 193.0 |
| 34 | 24.0 | 24.0 | 94 | 66.5 | 66.5 | 54 | 108.9 | 108.9 | 14 | 151.3 | 151.3 | 74 | 193.7 | 193.7 |
| 35 | 24.7 | 24.7 | 95 | 67.2 | 67.2 | 55 | 109.6 | 109.6 | 15 | 152.0 | 152.0 | 75 | 194.5 | ·194.5 |
| 36 | 25.5 | 25.5 | 96 | 67.9 | 67.9 | 56 | 110.3 | 110.3 | 16 | 152.7 | 152.7 | 76 | 195.2 | 195.2 |
| 37 | 26.2 | 26.2 | 97 | 68.6 | 68.6 | 57 | 111.0 | 111.0 | 17 | 153.4 | 153.4 | 77 | 195.9 | 195.9 |
| 38 | 26.9 | 26.9 | 98 | 69.3 | 69.3 | 58 | 111.7 | 111.7 | 18 | 154.1 | 154.1 | 78 | 196.6 | 196.6 |
| 39 | 27.6 | 27.6 | 99 | 70.0 | 70.0 | 59 | 112.4 | 112.4 | 19 | 154.9 | 154.9 | 79 | 197.3 | 197.3 |
| 40 | 28.3 | 28.3 | 100 | 70.7 | 70.7 | 60 | 113.1 | 113.1 | 20 | 155.6 | 155.6 | 80 | 198.0 | 198.0 |
| 41 | 29.0 | 29.0 | 101 | 71.4 | 71.4 | 161 | 113.8 | 113.8 | 221 | 156.3 | 156.3 | 281 | 198.7 | 198.7 |
| 42 | 29.7 | 29.7 | 02 | 72.1 | 72.1 | 62 | 114.6 | 114.6 | 22 | 157.0 | 157.0 | 82 | 199.4 | 199.4 |
| 43 | 30.4 | 30.4 | 03 | 72.8 | 72.8 | 63 | 115.3 | 115.3 | 23 | 157.7 | 157.7 | 83 | 200.1 | 200.1 |
| 44 | 31.1 | 31.1 | 04 | 73.5 | 73.5 | 64 | 116.0 | 116.0 | 24 | 158.4 | 158.4 | 84 | 200.8 | 200.8 |
| 45 | 31.8 | 31.8 | 05 | 74.2 | 74.2 | 65 | 116.7 | 116.7 | 25 | 159.1 | 159.1 | 85 | 201.5 | 201.5 |
| 46 | ·32.5 | 32.5 | 06 | 75.0 | 75.0 | 66 | 117.4 | 117.4 | 26 | 159.8 | 159.8 | 86 | 202.2 | 202.2 |
| 47 | 33.2 | 33.2 | 07 | 75.7 | 75.7 | 67 | 118.1 | 118.1 | 27 | 160.5 | 160.5 | 87 | 202.9 | 202.9 |
| 48 | 33.9 | 33.9 | 08 | 76.4 | 76.4 | 68 | 118.8 | 118.8 | 28 | 161.2 | 161.2 | 88 | 203.6 | 203.6 |
| 49 | 34.6 | 34.6 | 09 | 77.1 | 77.1 | 69 | 119.5 | 119.5 | 29 | 161.9 | 161.9 | 89 | 204.4 | 204.4 |
| 50 | 35.4 | 35.4 | 10 | 77.8 | 77.8 | 70 | 120.2 | 120.2 | 30 | 162.6 | 162.6 | 90 | 205.1 | 205.1 |
| 51 | 36.1 | 36.1 | 111 | 78.5 | 78.5 | 171 | 120.9 | 120.9 | 231 | 163.3 | 163.3 | 291 | 205.8 | 205.8 |
| 52 | 36.8 | 36.8 | 12 | 79.2 | 79.2 | 72 | 121.6 | 121.6 | 32 | 164.0 | 164.0 | 92 | 206.5 | 206.5 |
| 53 | 37.5 | 37.5 | 13 | 79.9 | 79.9 | 73 | 122.3 | 122.3 | 33 | 164.8 | 164.8 | 93 | 207.2 | 207.2 |
| 54 | 38.2 | 38.2 | 14 | 80.6 | 80.6 | 74 | 123.0 | 123.0 | 34 | 165.5 | 165.5 | 94 | 207.9 | 207.9 |
| 55 | 38.9 | 38.9 | 15 | 81.3 | 81.3 | 75 | 123.7 | 123.7 | 35 | 166.2 | 166.2 | 95 | 208.6 | 208.6 |
| 56 | 39.6 | 39.6 | 16 | 82.0 | 82.0 | 76 | 124.5 | 124.5 | 36 | 166.9 | 166.9 | 96 | 209.3 | 209.3 |
| 57 | 40.3 | 40.3 | 17 | 82.7 | 82.7 | 77 | 125.2 | 125.2 | 37 | 167.6 | 167.6 | 97 | 210.0 | 210.0 |
| 58 | 41.0 | 41.0 | 18 | 83.4 | 83.4 | 78 | 125.9 | 125.9 | 38 | 168.3 | 168.3 | 98 | 210.7 | 210.7 |
| 59 | 41.7 | 41.7 | 19 | 84.1 | 84.1 | 79 | 126.6 | 126.6 | 39 | 169.0 | 169.0 | 99 | 211.4 | 211.4 |
| 60 | 42.4 | 42.4 | 20 | 84.9 | 84.9 | 80 | 127.3 | 127.3 | 40 | 169.7 | 169.7 | 300 | 212.1 | 212.1 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

45° (135°, 225°, 315°).

TABLE 2. [Page 457

Difference of Latitude and Departure for 45° (135°, 225°, 315°).

| Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. | Dist. | Lat. | Dep. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 212.8 | 212.8 | 361 | 255.3 | 255.3 | 421 | 297.7 | 297.7 | 481 | 340.1 | 340.1 | 541 | 382.5 | 382.5 |
| 02 | 213.5 | 213.5 | 62 | 256.0 | 256.0 | 22 | 298.4 | 298.4 | 82 | 340.8 | 340.8 | 42 | 383.2 | 383.2 |
| 03 | 214.3 | 214.3 | 63 | 256.7 | 256.7 | 23 | 299.1 | 299.1 | 83 | 341.5 | 341.5 | 43 | 383.9 | 383.9 |
| 04 | 215.0 | 215.0 | 64 | 257.4 | 257.4 | 24 | 299.8 | 299.8 | 84 | 342.2 | 342.2 | 44 | 384.7 | 384.7 |
| 05 | 215.7 | 215.7 | 65 | 258.1 | 258.1 | 25 | 300.5 | 300.5 | 85 | 342.9 | 342.9 | 45 | 385.4 | 385.4 |
| 06 | 216.4 | 216.4 | 66 | 258.8 | 258.8 | 26 | 301.2 | 301.2 | 86 | 343.6 | 343.6 | 46 | 386.1 | 386.1 |
| 07 | 217.1 | 217.1 | 67 | 259.5 | 259.5 | 27 | 301.9 | 301.9 | 87 | 344.3 | 344.3 | 47 | 386.8 | 386.8 |
| 08 | 217.8 | 217.8 | 68 | 260.2 | 260.2 | 28 | 302.6 | 302.6 | 88 | 345.1 | 345.1 | 48 | 387.5 | 387.5 |
| 09 | 218.5 | 218.5 | 69 | 260.9 | 260.9 | 29 | 303.4 | 303.4 | 89 | 345.8 | 345.8 | 49 | 388.2 | 388.2 |
| 10 | 219.2 | 219.2 | 70 | 261.6 | 261.6 | 30 | 304.1 | 304.1 | 90 | 346.5 | 346.5 | 50 | 388.9 | 388.9 |
| 311 | 219.9 | 219.9 | 371 | 262.3 | 262.3 | 431 | 304.8 | 304.8 | 491 | 347.2 | 347.2 | 551 | 389.6 | 389.6 |
| 12 | 220.6 | 220.6 | 72 | 263.0 | 263.0 | 32 | 305.5 | 305.5 | 92 | 347.9 | 347.9 | 52 | 390.3 | 390.3 |
| 13 | 221.3 | 221.3 | 73 | 263.8 | 263.8 | 33 | 306.2 | 306.2 | 93 | 348.6 | 348.6 | 53 | 391.0 | 391.0 |
| 14 | 222.0 | 222.0 | 74 | 264.5 | 264.5 | 34 | 306.9 | 306.9 | 94 | 349.3 | 349.3 | 54 | 391.7 | 391.7 |
| 15 | 222.7 | 222.7 | 75 | 265.2 | 265.2 | 35 | 307.6 | 307.6 | 95 | 350.0 | 350.0 | 55 | 392.4 | 392.4 |
| 16 | 223.4 | 223.4 | 76 | 265.9 | 265.9 | 36 | 308.3 | 308.3 | 96 | 350.7 | 350.7 | 56 | 393.1 | 393.1 |
| 17 | 224.2 | 224.2 | 77 | 266.6 | 266.6 | 37 | 309.0 | 309.0 | 97 | 351.4 | 351.4 | 57 | 393.9 | 393.9 |
| 18 | 224.9 | 224.9 | 78 | 267.3 | 267.3 | 38 | 309.7 | 309.7 | 98 | 352.1 | 352.1 | 58 | 394.6 | 394.6 |
| 19 | 225.6 | 225.6 | 79 | 268.0 | 268.0 | 39 | 310.4 | 310.4 | 99 | 352.8 | 352.8 | 59 | 395.3 | 395.3 |
| 20 | 226.3 | 226.3 | 80 | 268.7 | 268.7 | 40 | 311.1 | 311.1 | 500 | 353.5 | 353.5 | 60 | 396.0 | 396.0 |
| 321 | 227.0 | 227.0 | 381 | 269.4 | 269.4 | 441 | 311.8 | 311.8 | 501 | 354.3 | 354.3 | 561 | 396.7 | 396.7 |
| 22 | 227.7 | 227.7 | 82 | 270.1 | 270.1 | 42 | 312.5 | 312.5 | 02 | 355.0 | 355.0 | 62 | 397.4 | 397.4 |
| 23 | 228.4 | 228.4 | 83 | 270.8 | 270.8 | 43 | 313.3 | 313.3 | 03 | 355.7 | 355.7 | 63 | 398.1 | 398.1 |
| 24 | 229.1 | 229.1 | 84 | 271.5 | 271.5 | 44 | 314.0 | 314.0 | 04 | 356.4 | 356.4 | 64 | 398.8 | 398.8 |
| 25 | 229.8 | 229.8 | 85 | 272.2 | 272.2 | 45 | 314.7 | 314.7 | 05 | 357.1 | 357.1 | 65 | 399.5 | 399.5 |
| 26 | 230.5 | 230.5 | 86 | 272.9 | 272.9 | 46 | 315.4 | 315.4 | 06 | 357.8 | 357.8 | 66 | 400.2 | 400.2 |
| 27 | 231.2 | 231.2 | 87 | 273.7 | 273.7 | 47 | 316.1 | 316.1 | 07 | 358.5 | 358.5 | 67 | 400.9 | 400.9 |
| 28 | 231.9 | 231.9 | 88 | 274.4 | 274.4 | 48 | 316.8 | 316.8 | 08 | 359.2 | 359.2 | 68 | 401.6 | 401.6 |
| 29 | 232.6 | 232.6 | 89 | 275.1 | 275.1 | 49 | 317.5 | 317.5 | 09 | 359.9 | 359.9 | 69 | 402.3 | 402.3 |
| 30 | 233.3 | 233.3 | 90 | 275.8 | 275.8 | 50 | 318.2 | 318.2 | 10 | 360.6 | 360.6 | 70 | 403.0 | 403.0 |
| 331 | 234.1 | 234.1 | 391 | 276.5 | 276.5 | 451 | 318.9 | 318.9 | 511 | 361.3 | 361.3 | 571 | 403.8 | 403.8 |
| 32 | 234.8 | 234.8 | 92 | 277.2 | 277.2 | 52 | 319.6 | 319.6 | 12 | 362.0 | 362.0 | 72 | 404.5 | 404.5 |
| 33 | 235.5 | 235.5 | 93 | 277.9 | 277.9 | 53 | 320.3 | 320.3 | 13 | 362.7 | 362.7 | 73 | 405.2 | 405.2 |
| 34 | 236.2 | 236.2 | 94 | 278.6 | 278.6 | 54 | 321.0 | 321.0 | 14 | 363.5 | 363.5 | 74 | 405.9 | 405.9 |
| 35 | 236.9 | 236.9 | 95 | 279.3 | 279.3 | 55 | 321.7 | 321.7 | 15 | 364.2 | 364.2 | 75 | 406.6 | 406.6 |
| 36 | 237.6 | 237.6 | 96 | 280.0 | 280.0 | 56 | 322.4 | 322.4 | 16 | 364.9 | 364.9 | 76 | 407.3 | 407.3 |
| 37 | 238.3 | 238.3 | 97 | 280.7 | 280.7 | 57 | 323.2 | 323.2 | 17 | 365.6 | 365.6 | 77 | 408.0 | 408.0 |
| 38 | 239.0 | 239.0 | 98 | 281.4 | 281.4 | 58 | 323.9 | 323.9 | 18 | 366.3 | 366.3 | 78 | 408.7 | 408.7 |
| 39 | 239.7 | 239.7 | 99 | 282.1 | 282.1 | 59 | 324.6 | 324.6 | 19 | 367.0 | 367.0 | 79 | 409.4 | 409.4 |
| 40 | 240.4 | 240.4 | 400 | 282.8 | 282.8 | 60 | 325.3 | 325.3 | 20 | 367.7 | 367.7 | 80 | 410.1 | 410.1 |
| 341 | 241.1 | 241.1 | 401 | 283.6 | 283.6 | 461 | 326.0 | 326.0 | 521 | 368.4 | 368.4 | 581 | 410.8 | 410.8 |
| 42 | 241.8 | 241.8 | 02 | 284.3 | 284.3 | 62 | 326.7 | 326.7 | 22 | 369.1 | 369.1 | 82 | 411.5 | 411.5 |
| 43 | 242.5 | 242.5 | 03 | 285.0 | 285.0 | 63 | 327.4 | 327.4 | 23 | 369.8 | 369.8 | 83 | 412.2 | 412.2 |
| 44 | 243.2 | 243.2 | 04 | 285.7 | 285.7 | 64 | 328.1 | 328.1 | 24 | 370.5 | 370.5 | 84 | 412.9 | 412.9 |
| 45 | 244.0 | 244.0 | 05 | 286.4 | 286.4 | 65 | 328.8 | 328.8 | 25 | 371.2 | 371.2 | 85 | 413.7 | 413.7 |
| 46 | 244.7 | 244.7 | 06 | 287.1 | 287.1 | 66 | 329.5 | 329.5 | 26 | 371.9 | 371.9 | 86 | 414.4 | 414.4 |
| 47 | 245.4 | 245.4 | 07 | 287.8 | 287.8 | 67 | 330.2 | 330.2 | 27 | 372.6 | 372.6 | 87 | 415.1 | 415.1 |
| 48 | 246.1 | 246.1 | 08 | 288.5 | 288.5 | 68 | 330.9 | 330.9 | 28 | 373.4 | 373.4 | 88 | 415.8 | 415.8 |
| 49 | 246.8 | 246.8 | 09 | 289.2 | 289.2 | 69 | 331.6 | 331.6 | 29 | 374.1 | 374.1 | 89 | 416.5 | 416.5 |
| 50 | 247.5 | 247.5 | 10 | 289.9 | 289.9 | 70 | 332.3 | 332.3 | 30 | 374.8 | 374.8 | 90 | 417.2 | 417.2 |
| 351 | 248.2 | 248.2 | 411 | 290.6 | 290.6 | 471 | 333.1 | 333.1 | 531 | 375.5 | 375.5 | 591 | 417.9 | 417.9 |
| 52 | 248.9 | 248.9 | 12 | 291.3 | 291.3 | 72 | 333.8 | 333.8 | 32 | 376.2 | 376.2 | 92 | 418.6 | 418.6 |
| 53 | 249.6 | 249.6 | 13 | 292.0 | 292.0 | 73 | 334.5 | 334.5 | 33 | 376.9 | 376.9 | 93 | 419.3 | 419.3 |
| 54 | 250.3 | 250.3 | 14 | 292.7 | 292.7 | 74 | 335.2 | 335.2 | 34 | 377.6 | 377.6 | 94 | 420.0 | 420.0 |
| 55 | 251.0 | 251.0 | 15 | 293.5 | 293.5 | 75 | 335.9 | 335.9 | 35 | 378.3 | 378.3 | 95 | 420.7 | 420.7 |
| 56 | 251.7 | 251.7 | 16 | 294.2 | 294.2 | 76 | 336.6 | 336.6 | 36 | 379.0 | 379.0 | 96 | 421.4 | 421.4 |
| 57 | 252.4 | 252.4 | 17 | 294.9 | 294.9 | 77 | 337.3 | 337.3 | 37 | 379.7 | 379.7 | 97 | 422.1 | 422.1 |
| 58 | 253.1 | 253.1 | 18 | 295.6 | 295.6 | 78 | 338.0 | 338.0 | 38 | 380.4 | 380.4 | 98 | 422.8 | 422.8 |
| 59 | 253.9 | 253.9 | 19 | 296.3 | 296.3 | 79 | 338.7 | 338.7 | 39 | 381.1 | 381.1 | 99 | 423.6 | 423.6 |
| 60 | 254.6 | 254.6 | 20 | 297.0 | 297.0 | 80 | 339.4 | 339.4 | 40 | 381.8 | 381.8 | 600 | 424.3 | 424.3 |
| Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. | Dist. | Dep. | Lat. |

45° (135°, 225°, 315°).

# TABLE 3.

### Meridional Parts, or Increased Latitudes.

$$\text{Comp. } \frac{1}{293.465}$$

| M. | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 59.6 | 119.2 | 178.9 | 238.6 | 298.3 | 358.2 | 418.2 | 478.3 | 538.6 | 0 |
| 1 | 1.0 | 60.6 | 20.2 | 79.9 | 39.6 | 99.3 | 59.2 | 19.2 | 79.3 | 39.6 | 1 |
| 2 | 2.0 | 61.6 | 21.2 | 80.8 | 40.6 | 300.3 | 60.2 | 20.2 | 80.3 | 40.6 | 2 |
| 3 | 3.0 | 62.6 | 22.2 | 81.8 | 41.6 | 01.3 | 61.2 | 21.2 | 81.3 | 41.6 | 3 |
| 4 | 4.0 | 63.6 | 23.2 | 82.8 | 42.5 | 02.3 | 62.2 | 22.2 | 82.3 | 42.6 | 4 |
| 5 | 5.0 | 64.6 | 124.2 | 183.8 | 243.5 | 303.3 | 363.2 | 423.2 | 483.3 | 543.6 | 5 |
| 6 | 6.0 | 65.6 | 25.2 | 84.8 | 44.5 | 04.3 | 64.2 | 24.2 | 84.3 | 44.6 | 6 |
| 7 | 7.0 | 66.5 | 26.2 | 85.8 | 45.5 | 05.3 | 65.2 | 25.2 | 85.3 | 45.6 | 7 |
| 8 | 7.9 | 67.5 | 27.2 | 86.8 | 46.5 | 06.3 | 66.2 | 26.2 | 86.3 | 46.6 | 8 |
| 9 | 8.9 | 68.5 | 28.2 | 87.8 | 47.5 | 07.3 | 67.2 | 27.2 | 87.3 | 47.6 | 9 |
| 10 | 9.9 | 69.5 | 129.1 | 188.8 | 248.5 | 308.3 | 368.2 | 428.2 | 488.3 | 548.6 | 10 |
| 11 | 10.9 | 70.5 | 30.1 | 89.8 | 49.5 | 09.3 | 69.2 | 29.2 | 89.3 | 49.6 | 11 |
| 12 | 11.9 | 71.5 | 31.1 | 90.8 | 50.5 | 10.3 | 70.2 | 30.2 | 90.4 | 50.6 | 12 |
| 13 | 12.9 | 72.5 | 32.1 | 91.8 | 51.5 | 11.3 | 71.2 | 31.2 | 91.4 | 51.7 | 13 |
| 14 | 13.9 | 73.5 | 33.1 | 92.8 | 52.5 | 12.3 | 72.2 | 32.2 | 92.4 | 52.7 | 14 |
| 15 | 14.9 | 74.5 | 134.1 | 193.8 | 253.5 | 313.3 | 373.2 | 433.2 | 493.4 | 553.7 | 15 |
| 16 | 15.9 | 75.5 | 35.1 | 94.8 | 54.5 | 14.3 | 74.2 | 34.2 | 94.4 | 54.7 | 16 |
| 17 | 16.9 | 76.5 | 36.1 | 95.8 | 55.5 | 15.3 | 75.2 | 35.2 | 95.4 | 55.7 | 17 |
| 18 | 17.9 | 77.5 | 37.1 | 96.8 | 56.5 | 16.3 | 76.2 | 36.2 | 96.4 | 56.7 | 18 |
| 19 | 18.9 | 78.5 | 38.1 | 97.8 | 57.5 | 17.3 | 77.2 | 37.2 | 97.4 | 57.7 | 19 |
| 20 | 19.9 | 79.5 | 139.1 | 198.8 | 258.5 | 318.3 | 378.2 | 438.2 | 498.4 | 558.7 | 20 |
| 21 | 20.9 | 80.5 | 40.1 | 99.7 | 59.5 | 19.3 | 79.2 | 39.2 | 99.4 | 59.7 | 21 |
| 22 | 21.9 | 81.5 | 41.1 | 200.7 | 60.5 | 20.3 | 80.2 | 40.2 | 500.4 | 60.7 | 22 |
| 23 | 22.8 | 82.4 | 42.1 | 01.7 | 61.5 | 21.3 | 81.2 | 41.2 | 01.4 | 61.7 | 23 |
| 24 | 23.8 | 83.4 | 43.1 | 02.7 | 62.5 | 22.3 | 82.2 | 42.2 | 02.4 | 62.7 | 24 |
| 25 | 24.8 | 84.4 | 144.1 | 203.7 | 263.5 | 323.3 | 383.2 | 443.2 | 503.4 | 563.7 | 25 |
| 26 | 25.8 | 85.4 | 45.1 | 04.7 | 64.5 | 24.3 | 84.2 | 44.2 | 04.4 | 64.7 | 26 |
| 27 | 26.8 | 86.4 | 46.0 | 05.7 | 65.5 | 25.3 | 85.2 | 45.2 | 05.4 | 65.7 | 27 |
| 28 | 27.8 | 87.4 | 47.0 | 06.7 | 66.5 | 26.3 | 86.2 | 46.2 | 06.4 | 66.8 | 28 |
| 29 | 28.8 | 88.4 | 48.0 | 07.7 | 67.4 | 27.3 | 87.2 | 47.2 | 07.4 | 67.8 | 29 |
| 30 | 29.8 | 89.4 | 149.0 | 208.7 | 268.4 | 328.3 | 388.2 | 448.2 | 508.4 | 568.8 | 30 |
| 31 | 30.8 | 90.4 | 50.0 | 09.7 | 69.4 | 29.3 | 89.2 | 49.2 | 09.4 | 69.8 | 31 |
| 32 | 31.8 | 91.4 | 51.0 | 10.7 | 70.4 | 30.3 | 90.2 | 50.2 | 10.4 | 70.8 | 32 |
| 33 | 32.8 | 92.4 | 52.0 | 11.7 | 71.4 | 31.3 | 91.2 | 51.2 | 11.4 | 71.8 | 33 |
| 34 | 33.8 | 93.4 | 53.0 | 12.7 | 72.4 | 32.3 | 92.2 | 52.2 | 12.4 | 72.8 | 34 |
| 35 | 34.8 | 94.4 | 154.0 | 213.7 | 273.4 | 333.3 | 393.2 | 453.2 | 513.4 | 573.8 | 35 |
| 36 | 35.8 | 95.4 | 55.0 | 14.7 | 74.4 | 34.3 | 94.2 | 54.3 | 14.5 | 74.8 | 36 |
| 37 | 36.7 | 96.4 | 56.0 | 15.7 | 75.4 | 35.3 | 95.2 | 55.3 | 15.5 | 75.8 | 37 |
| 38 | 37.7 | 97.3 | 57.0 | 16.7 | 76.4 | 36.2 | 96.2 | 56.3 | 16.5 | 76.8 | 38 |
| 39 | 38.7 | 98.3 | 58.0 | 17.7 | 77.4 | 37.2 | 97.2 | 57.3 | 17.5 | 77.8 | 39 |
| 40 | 39.7 | 99.3 | 159.0 | 218.7 | 278.4 | 338.2 | 398.2 | 458.3 | 518.5 | 578.8 | 40 |
| 41 | 40.7 | 100.3 | 60.0 | 19.7 | 79.4 | 39.2 | 99.2 | 59.3 | 19.5 | 79.9 | 41 |
| 42 | 41.7 | 01.3 | 61.0 | 20.6 | 80.4 | 40.2 | 400.2 | 60.3 | 20.5 | 80.9 | 42 |
| 43 | 42.7 | 02.3 | 62.0 | 21.6 | 81.4 | 41.2 | 01.2 | 61.3 | 21.5 | 81.9 | 43 |
| 44 | 43.7 | 03.3 | 63.0 | 22.6 | 82.4 | 42.2 | 02.2 | 62.3 | 22.5 | 82.9 | 44 |
| 45 | 44.7 | 104.3 | 164.0 | 223.6 | 283.4 | 343.2 | 403.2 | 463.3 | 523.5 | 583.9 | 45 |
| 46 | 45.7 | 05.3 | 65.0 | 24.6 | 84.4 | 44.2 | 04.2 | 64.3 | 24.5 | 84.9 | 46 |
| 47 | 46.7 | 06.3 | 66.0 | 25.6 | 85.4 | 45.2 | 05.2 | 65.3 | 25.5 | 85.9 | 47 |
| 48 | 47.7 | 07.3 | 67.0 | 26.6 | 86.4 | 46.2 | 06.2 | 66.3 | 26.5 | 86.9 | 48 |
| 49 | 48.7 | 08.3 | 68.0 | 27.6 | 87.4 | 47.2 | 07.2 | 67.3 | 27.5 | 87.9 | 49 |
| 50 | 49.7 | 109.3 | 168.9 | 228.6 | 288.4 | 348.2 | 408.2 | 468.3 | 528.5 | 588.9 | 50 |
| 51 | 50.7 | 10.3 | 69.9 | 29.6 | 89.4 | 49.2 | 09.2 | 69.3 | 29.5 | 89.9 | 51 |
| 52 | 51.6 | 11.3 | 70.9 | 30.6 | 90.4 | 50.2 | 10.2 | 70.3 | 30.5 | 90.9 | 52 |
| 53 | 52.6 | 12.3 | 71.9 | 31.6 | 91.4 | 51.2 | 11.2 | 71.3 | 31.5 | 91.9 | 53 |
| 54 | 53.6 | 13.2 | 72.9 | 32.6 | 92.4 | 52.2 | 12.2 | 72.3 | 32.5 | 93.0 | 54 |
| 55 | 54.6 | 114.2 | 173.9 | 233.6 | 293.4 | 353.2 | 413.2 | 473.3 | 533.5 | 594.0 | 55 |
| 56 | 55.6 | 15.2 | 74.9 | 34.6 | 94.4 | 54.2 | 14.2 | 74.3 | 34.6 | 95.0 | 56 |
| 57 | 56.6 | 16.2 | 75.9 | 35.6 | 95.4 | 55.2 | 15.2 | 75.3 | 35.6 | 96.0 | 57 |
| 58 | 57.6 | 17.2 | 76.9 | 36.6 | 96.3 | 56.2 | 16.2 | 76.3 | 36.6 | 97.0 | 58 |
| 59 | 58.6 | 18.2 | 77.9 | 37.6 | 97.3 | 57.2 | 17.2 | 77.3 | 37.6 | 98.0 | 59 |
| M. | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | M. |

TABLE 3. [Page 459

## Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

| M. | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 599.0 | 659.6 | 720.5 | 781.5 | 842.8 | 904.4 | 966.3 | 1028.5 | 1091.0 | 1153.9 | 0 |
| 1 | 600.0 | 60.6 | 21.5 | 82.5 | 43.9 | 05.4 | 67.3 | 29.5 | 92.0 | 54.9 | 1 |
| 2 | 01.0 | 61.7 | 22.5 | 83.6 | 44.9 | 06.5 | 68.3 | 30.5 | 93.1 | 56.0 | 2 |
| 3 | 02.0 | 62.7 | 23.5 | 84.6 | 45.9 | 07.5 | 69.4 | 31.6 | 94.1 | 57.0 | 3 |
| 4 | 03.0 | 63.7 | 24.5 | 85.6 | 46.9 | 08.5 | 70.4 | 32.6 | 95.2 | 58.1 | 4 |
| 5 | 604.1 | 664.7 | 725.5 | 786.6 | 847.9 | 909.6 | 971.4 | 1033.7 | 1096.2 | 1159.1 | 5 |
| 6 | 05.1 | 65.7 | 26.6 | 87.6 | 49.0 | 10.6 | 72.5 | 34.7 | 97.3 | 60.2 | 6 |
| 7 | 06.1 | 66.7 | 27.6 | 88.7 | 50.0 | 11.6 | 73.5 | 35.7 | 98.3 | 61.2 | 7 |
| 8 | 07.1 | 67.7 | 28.6 | 89.7 | 51.0 | 12.6 | 74.6 | 36.8 | 99.4 | 62.3 | 8 |
| 9 | 08.1 | 68.7 | 29.6 | 90.7 | 52.0 | 13.7 | 75.6 | 37.8 | 1100.4 | 63.3 | 9 |
| 10 | 609.1 | 669.8 | 730.6 | 791.7 | 853.1 | 914.7 | 976.6 | 1038.9 | 1101.4 | 1164.4 | 10 |
| 11 | 10.1 | 70.8 | 31.6 | 92.7 | 54.1 | 15.7 | 77.7 | 39.9 | 02.5 | 65.4 | 11 |
| 12 | 11.1 | 71.8 | 32.7 | 93.8 | 55.1 | 16.8 | 78.7 | 40.9 | 03.5 | 66.5 | 12 |
| 13 | 12.1 | 72.8 | 33.7 | 94.8 | 56.1 | 17.8 | 79.7 | 42.0 | 04.6 | 67.5 | 13 |
| 14 | 13.1 | 73.8 | 34.7 | 95.8 | 57.2 | 18.8 | 80.8 | 43.0 | 05.6 | 68.6 | 14 |
| 15 | 614.1 | 674.8 | 735.7 | 796.8 | 858.2 | 919.8 | 981.8 | 1044.1 | 1106.7 | 1169.7 | 15 |
| 16 | 15.2 | 75.8 | 36.7 | 97.8 | 59.2 | 20.9 | 82.8 | 45.1 | 07.7 | 70.7 | 16 |
| 17 | 16.2 | 76.8 | 37.7 | 98.9 | 60.2 | 21.9 | 83.9 | 46.1 | 08.8 | 71.8 | 17 |
| 18 | 17.2 | 77.9 | 38.8 | 99.9 | 61.3 | 22.9 | 84.9 | 47.2 | 09.8 | 72.8 | 18 |
| 19 | 18.2 | 78.9 | 39.8 | 800.9 | 62.3 | 24.0 | 85.9 | 48.2 | 10.9 | 73.9 | 19 |
| 20 | 619.2 | 679.9 | 740.8 | 801.9 | 863.3 | 925.0 | 987.0 | 1049.3 | 1111.9 | 1174.9 | 20 |
| 21 | 20.2 | 80.9 | 41.8 | 02.9 | 64.3 | 26.0 | 88.0 | 50.3 | 13.0 | 76.0 | 21 |
| 22 | 21.2 | 81.9 | 42.8 | 04.0 | 65.4 | 27.1 | 89.0 | 51.3 | 14.0 | 77.0 | 22 |
| 23 | 22.2 | 82.9 | 43.8 | 05.0 | 66.4 | 28.1 | 90.1 | 52.4 | 15.0 | 78.1 | 23 |
| 24 | 23.2 | 83.9 | 44.9 | 06.0 | 67.4 | 29.1 | 91.1 | 53.4 | 16.1 | 79.1 | 24 |
| 25 | 624.2 | 684.9 | 745.9 | 807.0 | 868.5 | 930.1 | 992.1 | 1054.5 | 1117.1 | 1180.2 | 25 |
| 26 | 25.3 | 86.0 | 46.9 | 08.1 | 69.5 | 31.2 | 93.2 | 55.5 | 18.2 | 81.2 | 26 |
| 27 | 26.3 | 87.0 | 47.9 | 09.1 | 70.5 | 32.2 | 94.2 | 56.6 | 19.2 | 82.3 | 27 |
| 28 | 27.3 | 88.0 | 48.9 | 10.1 | 71.5 | 33.2 | 95.3 | 57.6 | 20.3 | 83.3 | 28 |
| 29 | 28.3 | 89.0 | 49.9 | 11.1 | 72.6 | 34.3 | 96.3 | 58.6 | 21.3 | 84.4 | 29 |
| 30 | 629.3 | 690.0 | 751.0 | 812.1 | 873.6 | 935.3 | 997.3 | 1059.7 | 1122.4 | 1185.5 | 30 |
| 31 | 30.3 | 91.0 | 52.0 | 13.2 | 74.6 | 36.3 | 98.4 | 60.7 | 23.4 | 86.5 | 31 |
| 32 | 31.3 | 92.0 | 53.0 | 14.2 | 75.6 | 37.4 | 99.4 | 61.8 | 24.5 | 87.6 | 32 |
| 33 | 32.3 | 93.1 | 54.0 | 15.2 | 76.7 | 38.4 | 1000.4 | 62.8 | 25.5 | 88.6 | 33 |
| 34 | 33.3 | 94.1 | 55.0 | 16.2 | 77.7 | 39.4 | 01.5 | 63.9 | 26.6 | 89.7 | 34 |
| 35 | 634.3 | 695.1 | 756.0 | 817.3 | 878.7 | 940.5 | 1002.5 | 1064.9 | 1127.6 | 1190.7 | 35 |
| 36 | 35.4 | 96.1 | 57.1 | 18.3 | 79.7 | 41.5 | 03.6 | 65.9 | 28.7 | 91.8 | 36 |
| 37 | 36.4 | 97.1 | 58.1 | 19.3 | 80.8 | 42.5 | 04.6 | 67.0 | 29.7 | 92.8 | 37 |
| 38 | 37.4 | 98.1 | 59.1 | 20.3 | 81.8 | 43.6 | 05.6 | 68.0 | 30.8 | 93.9 | 38 |
| 39 | 38.4 | 99.1 | 60.1 | 21.3 | 82.8 | 44.6 | 06.7 | 69.1 | 31.8 | 95.0 | 39 |
| 40 | 639.4 | 700.2 | 761.1 | 822.4 | 883.8 | 945.6 | 1007.7 | 1070.1 | 1132.9 | 1196.0 | 40 |
| 41 | 40.4 | 01.2 | 62.2 | 23.4 | 84.9 | 46.7 | 08.7 | 71.2 | 33.9 | 97.1 | 41 |
| 42 | 41.4 | 02.2 | 63.2 | 24.4 | 85.9 | 47.7 | 09.8 | 72.2 | 35.0 | 98.1 | 42 |
| 43 | 42.4 | 03.2 | 64.2 | 25.4 | 86.9 | 48.7 | 10.8 | 73.2 | 36.0 | 99.2 | 43 |
| 44 | 43.4 | 04.2 | 65.2 | 26.5 | 88.0 | 49.7 | 11.8 | 74.3 | 37.1 | 1200.2 | 44 |
| 45 | 644.5 | 705.2 | 766.2 | 827.5 | 889.0 | 950.8 | 1012.9 | 1075.3 | 1138.1 | 1201.3 | 45 |
| 46 | 45.5 | 06.2 | 67.3 | 28.5 | 90.0 | 51.8 | 13.9 | 76.4 | 39.2 | 02.3 | 46 |
| 47 | 46.5 | 07.3 | 68.3 | 29.5 | 91.0 | 52.8 | 15.0 | 77.4 | 40.2 | 03.4 | 47 |
| 48 | 47.5 | 08.3 | 69.3 | 30.5 | 92.1 | 53.9 | 16.0 | 78.5 | 41.3 | 04.5 | 48 |
| 49 | 48.5 | 09.3 | 70.3 | 31.6 | 93.1 | 54.9 | 17.0 | 79.5 | 42.3 | 05.5 | 49 |
| 50 | 649.5 | 710.3 | 771.3 | 832.6 | 894.1 | 955.9 | 1018.1 | 1080.5 | 1143.4 | 1206.6 | 50 |
| 51 | 50.5 | 11.3 | 72.3 | 33.6 | 95.2 | 57.0 | 19.1 | 81.6 | 44.4 | 07.6 | 51 |
| 52 | 51.5 | 12.3 | 73.4 | 34.6 | 96.2 | 58.0 | 20.2 | 82.6 | 45.5 | 08.7 | 52 |
| 53 | 52.5 | 13.4 | 74.4 | 35.7 | 97.2 | 59.0 | 21.2 | 83.7 | 46.5 | 09.7 | 53 |
| 54 | 53.6 | 14.4 | 75.4 | 36.7 | 98.2 | 60.1 | 22.2 | 84.7 | 47.6 | 10.8 | 54 |
| 55 | 654.6 | 715.4 | 776.4 | 837.7 | 899.3 | 961.1 | 1023.3 | 1085.8 | 1148.6 | 1211.8 | 55 |
| 56 | 55.6 | 16.4 | 77.4 | 38.7 | 900.3 | 62.1 | 24.3 | 86.8 | 49.7 | 12.9 | 56 |
| 57 | 56.6 | 17.4 | 78.5 | 39.8 | 01.3 | 63.2 | 25.3 | 87.9 | 50.7 | 14.0 | 57 |
| 58 | 57.6 | 18.4 | 79.5 | 40.8 | 02.3 | 64.2 | 26.4 | 88.9 | 51.8 | 15.0 | 58 |
| 59 | 58.6 | 19.4 | 80.5 | 41.8 | 03.4 | 65.2 | 27.4 | 89.9 | 52.8 | 16.1 | 59 |
| M. | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | M. |

# TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

| M. | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1217.1 | 1280.8 | 1344.9 | 1409.5 | 1474.5 | 1540.1 | 1606.2 | 1672.9 | 1740.2 | 1808.1 | 0 |
| 1 | .18.2 | 81.9 | 46.0 | 10.6 | 75.6 | 41.2 | 07.3 | 74.0 | 41.3 | 09.2 | 1 |
| 2 | 19.3 | 82.9 | 47.1 | 11.6 | 76.7 | 42.3 | 08.4 | 75.1 | 42.4 | 10.4 | 2 |
| 3 | 20.3 | 84.0 | 48.1 | 12.7 | 77.8 | 43.4 | 09.5 | 76.2 | 43.6 | 11.5 | 3 |
| 4 | 21.4 | 85.1 | 49.2 | 13.8 | 78.9 | 44.5 | 10.6 | 77.4 | 44.7 | 12.6 | 4 |
| 5 | 1222.4 | 1286.1 | 1350.3 | 1414.9 | 1480.0 | 1545.6 | 1611.7 | 1678.5 | 1745.8 | 1813.8 | 5 |
| 6 | 23.5 | 87.2 | 51.4 | 16.0 | 81.1 | 46.7 | ·12.9 | 79.6 | 46.9 | 14.9 | 6 |
| 7 | 24.5 | 88.3 | 52.4 | 17.1 | 82.2 | 47.8 | 14.0 | 80.7 | 48.1 | 16.1 | 7 |
| 8 | 25.6 | 89.3 | 53.5 | 18.1 | 83.3 | 48.9 | 15.1 | 81.8 | 49.2 | 17.2 | 8 |
| 9 | 26.7 | 90.4 | 54.6 | 19.2 | 84.3 | 50.0 | 16.2 | 82.9 | 50.3 | 18.3 | 9 |
| 10 | 1227.7 | 1291.5 | 1355.7 | 1420.3 | 1485.4 | 1551.1 | 1617.3 | 1684.1 | 1751.5 | 1819.5 | 10 |
| 11 | 28.8 | 92.5 | 56.7 | 21.4 | 86.5 | 52.2 | 18.4 | 85.2 | 52.6 | 20.6 | 11 |
| 12 | 29.8 | 93.6 | 57.8 | 22.5 | 87.6 | 53.3 | 19.5 | 86.3 | 53.7 | 21.8 | 12 |
| 13 | 30.9 | 94.7 | 58.9· | 23.5 | 88.7 | 54.4 | 20.6 | 87.4 | 54.8 | 22.9 | 13 |
| 14 | 32.0 | 95.7 | 59.9 | 24.6 | 89.8 | 55.5 | 21.7 | 88.5 | 56.0 | 24.0 | 14 |
| 15 | 1233.0 | 1296.8 | 1361.0 | 1425.7 | 1490.9 | 1556.6 | 1622.8 | 1689.7 | 1757.1 | 1825.2 | 15 |
| 16 | 34.1 | 97.9 | 62.1 | 26.8 | 92.0 | 57.7 | 23.9 | 90.8 | 58.2 | 26.3 | 16 |
| 17 | 35.1 | 98.9 | 63.2 | 27.9 | 93.1 | 58.8 | 25.0 | 91.9 | 59.4 | 27.5 | 17 |
| 18 | 36.2 | 1300.0 | 64.2 | 29.0 | 94.2 | 59.9 | 26.2 | 93.0 | 60.5 | 28.6 | 18 |
| 19 | 37.3 | 01.1 | 65.3 | 30.0 | 95.2 | 61.0 | 27.3 | 94.1 | 61.6 | 29.7 | 19 |
| 20 | 1238.3 | 1302.1 | 1366.4 | 1431.1 | 1496.3 | 1562.1 | 1628.4 | 1695.3 | 1762.7 | 1830.9 | 20 |
| 21 | 39.4 | 03.2 | 67.5 | 32.2 | 97.4 | 63.2 | 29.5 | 96.4 | 63.9 | 32.0 | 21 |
| 22 | 40.4 | 04.3 | 68.5 | 33.3 | 98.5 | 64.3 | 30.6 | 97.5 | 65.0 | 33.2 | 22 |
| 23 | 41.5 | 05.3 | 69.6 | 34.4 | 99.6 | 65.4 | 31.7 | 98.6 | 66.1 | 34.3 | 23 |
| 24 | 42.6 | 06.4 | 70.7 | 35.4 | 1500.7 | 66.5 | 32.8 | 99.7 | 67.3 | 35.4 | 24 |
| 25 | 1243.6 | 1307.5 | 1371.8 | 1436.5 | 1501.8 | 1567.6 | 1633.9 | 1700.9 | 1768.4 | 1836.6 | 25 |
| 26 | 44.7 | 08.5 | 72.8 | 37.6 | 02.9 | 68.7 | 35.0 | 02.0 | 69.5 | 37.7 | 26 |
| 27 | 45.7 | 09.6 | 73.9 | 38.7 | 04.0 | 69.8 | 36.1 | 03.1 | 70.7 | 38.9 | 27 |
| 28 | 46.8 | 10.7 | 75.0 | 39.8 | 05.1 | 70.9 | 37.3 | 04.2 | 71.8 | 40.0 | 28 |
| 29 | 47.9 | 11.7 | 76.1 | 40.9 | 06.2 | 72.0 | 38.4 | 05.3 | 72.9 | 41.2 | 29 |
| 30 | 1248.9 | 1312.8 | 1377.1 | 1442.0 | 1507.3 | 1573.1 | 1639.5 | 1706.5 | 1774.1 | 1842.3 | 30 |
| 31 | 50.0 | 13.9 | 78.2 | 43.0 | 08.4 | 74.2 | 40.6 | ·07.6 | 75.2 | 43.4 | 31 |
| 32 | 51.0 | 14.9 | 79.3 | 44.1 | 09.4 | 75.3 | 41.7 | 08.7 | 76.3 | 44.6 | 32 |
| 33 | 52.1 | 16.0 | 80.4 | 45.2 | 10.5 | 76.4 | 42.8 | 09.8 | 77.4 | 45.7 | 33 |
| 34 | 53.2 | 17.1 | 81.5 | 46.3 | 11.6 | 77.5 | 43.9 | 10.9 | 78.6 | 46.9 | 34 |
| 35 | 1254.2 | 1318.2 | 1382.5 | 1447.4 | 1512.7 | 1578.6 | 1645.0 | 1712.1 | 1779.7 | 1848.0 | 35 |
| 36 | 55.3 | 19.2 | 83.6 | 48.5 | 13.8 | 79.7 | 46.2 | 13.2 | 80.8 | 49.2 | 36 |
| 37 | 56.4 | 20.3 | 84.7 | 49.5 | 14.9 | 80.8 | 47.3 | 14.3 | 82.0 | 50.3 | 37 |
| 38 | 57.4 | 21.4 | 85.8 | 50.6 | 16.0 | 81.9 | 48.4 | 15.4 | 83.1 | 51.4 | 38 |
| 39 | 58.5 | 22.4 | 86.8 | 51.7 | 17.1 | 83.0 | 49.5 | 16.6 | 84.2 | 52.6 | 39 |
| 40 | 1259.5 | 1323.5 | 1387.9 | 1452.8 | 1518.2 | 1584.1 | 1650.6 | 1717.7 | 1785.4 | 1853.7 | 40 |
| 41 | 60.6 | 24.6 | 89.0 | 53.9 | 19.3 | 85.2 | 51.7 | 18.8 | 86.5 | 54.9 | 41 |
| 42 | 61.7 | 25.6 | 90.1 | 55.0 | 20.4 | 86.3 | 52.8 | 19.9 | 87.6 | 56.0 | 42 |
| 43 | 62.7 | 26.7 | 91.1 | 56.1 | 21.5 | 87.4 | 53.9 | 21.1 | 88.8 | ·57.2 | 43 |
| 44 | 63.8 | 27.8 | 92.2 | 57.1 | 22.6 | 88.5 | 55.1 | 22.2 | 89.9 | 58.3 | 44 |
| 45 | 1264.9 | 1328.9 | 1393.3 | 1458.2 | 1523.7 | 1589.6 | 1656.2 | 1723.3 | 1791.1 | 1859.5 | 45 |
| 46 | 65.9 | ·29.9 | 94.4 | 59.3 | 24.8 | 90.7 | 57.3 | 24.4 | 92.2 | 60.6 | 46 |
| 47 | 67.0 | 31.0 | 95.5 | 60.4 | 25.9 | 91.8 | 58.4 | 25.5 | 93.3 | 61.8 | 47 |
| 48 | 68.0 | 32.1 | 96.5 | 61.5 | 27.0 | 92.9 | 59.5 | 26.7 | 94.5 | 62.9 | 48 |
| 49 | 69.1 | 33.1 | 97.6 | 62.6 | 28.0 | 94.1 | 60.6 | 27.8 | 95.6 | 64.0 | 49 |
| 50 | 1270.2 | 1334.2 | 1398.7 | 1463.7 | 1529.1 | 1595.2 | 1661.7 | 1728.9 | 1796.7 | 1865.2 | 50 |
| 51 | 71.2 | 35.3 | 99.8 | 64.8 | 30.2 | 96.3 | 62.9 | 30.0 | 97.9 | 66.3 | 51 |
| 52 | 72.3 | 36.3 | 1400.9 | 65.8 | 31.3 | 97.4 | 64.0 | 31.2 | 99.0 | 67.5 | 52 |
| 53 | 73.4 | 37.4 | 01.9 | 66.9 | 32.4 | 98.5 | 65.1 | 32.3 | 1800.1 | 68.6 | 53 |
| 54 | 74.4 | 38.5 | 03.0 | 68.0 | 33.5 | 99.6 | 66.2 | 33.4 | 01.3 | 69.8 | 54 |
| 55 | 1275.5 | 1339.6 | 1404.1 | 1469.1 | 1534.6 | 1600.7 | 1667.3 | 1734.5 | 1802.4 | 1870.9 | 55 |
| 56 | 76.6 | 40.6 | 05.2 | 70.2 | 35.7 | 01.8 | 68.4 | 35.7 | 03.5 | 72.1 | 56 |
| 57 | 77.6 | 41.7 | 06.2 | 71.3 | 36.8 | 02.9 | 69.5 | 36.8 | 04.7 | 73.2 | 57 |
| 58 | 78.7 | 42.8 | 07.3 | 72.4 | 37.9 | 04.0 | 70.7 | 37.9 | 05.8 | 74.4 | 58 |
| 59 | 79.7 | 43.8 | 08.4 | 73.5 | 39.0 | 05.1 | 71.8 | 39.1 | 07.0 | 75.5 | 59 |
| M. | 20° | 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | M. |

# TABLE 3. [Page 461

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$ .

| M. | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° | 39° | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1876.7 | 1946.0 | 2016.0 | 2086.8 | 2158.4 | 2230.9 | 2304.2 | 2378.5 | 2453.8 | 2530.2 | 0 |
| 1 | 77.8 | 47.1 | 17.2 | 88.0 | 59.6 | 32.1 | 05.5 | 79.8 | 55.1 | 31.5 | 1 |
| 2 | 79.0 | 48.3 | 18.3 | 89.2 | 60.8 | 33.3 | 06.7 | 81.0 | 56.4 | 32.8 | 2 |
| 3 | 80.1 | 49.4 | 19.5 | 90.3 | 62.0 | 34.5 | 07.9 | 82.3 | 57.6 | 34.0 | 3 |
| 4 | 81.3 | 50.6 | 20.7 | 91.5 | 63.2 | 35.7 | 09.2 | 83.5 | 58.9 | 35.3 | 4 |
| 5 | 1882.4 | 1951.8 | 2021.9 | 2092.7 | 2164.4 | 2236.9 | 2310.4 | 2384.8 | 2460.2 | 2536.6 | 5 |
| 6 | 83.6 | 52.9 | 23.0 | 93.9 | 65.6 | 38.2 | 11.6 | 86.0 | 61.4 | 37.9 | 6 |
| 7 | 84.7 | 54.1 | 24.2 | 95.1 | 66.8 | 39.4 | 12.9 | 87.3 | 62.7 | 39.2 | 7 |
| 8 | 85.9 | 55.3 | 25.4 | 96.3 | 68.0 | 40.6 | 14.1 | 88.5 | 64.0 | 40.5 | 8 |
| 9 | 87.0 | 56.4 | 26.6 | 97.5 | 69.2 | 41.8 | 15.3 | 89.8 | 65.2 | 41.7 | 9 |
| 10 | 1888.2 | 1957.6 | 2027.7 | 2098.7 | 2170.4 | 2243.0 | 2316.5 | 2391.0 | 2466.5 | 2543.0 | 10 |
| 11 | 89.3 | 58.7 | 28.9 | 99.8 | 71.6 | 44.2 | 17.8 | 92.3 | 67.8 | 44.3 | 11 |
| 12 | 90.5 | 59.9 | 30.1 | 2101.0 | 72.8 | 45.5 | 19.0 | 93.5 | 69.0 | 45.6 | 12 |
| 13 | 91.6 | 61.1 | 31.3 | 02.2 | 74.0 | 46.7 | 20.3 | 94.8 | 70.3 | 46.9 | 13 |
| 14 | 92.8 | 62.2 | 32.4 | 03.4 | 75.2 | 47.9 | 21.5 | 96.0 | 71.6 | 48.2 | 14 |
| 15 | 1893.9 | 1963.4 | 2033.6 | 2104.6 | 2176.4 | 2249.1 | 2322.7 | 2397.3 | 2472.8 | 2549.5 | 15 |
| 16 | 95.1 | 64.6 | 34.8 | 05.8 | 77.6 | 50.3 | 24.0 | 98.5 | 74.1 | 50.7 | 16 |
| 17 | 96.2 | 65.7 | 36.0 | 07.0 | 78.8 | 51.6 | 25.2 | 99.8 | 75.4 | 52.0 | 17 |
| 18 | 97.4 | 66.9 | 37.1 | 08.2 | 80.0 | 52.8 | 26.4 | 2401.0 | 76.6 | 53.3 | 18 |
| 19 | 98.5 | 68.1 | 38.3 | 09.4 | 81.2 | 54.0 | 27.7 | 02.3 | 77.9 | 54.6 | 19 |
| 20 | 1899.7 | 1969.2 | 2039.5 | 2110.6 | 2182.5 | 2255.2 | 2328.9 | 2403.5 | 2479.2 | 2555.9 | 20 |
| 21 | 1900.8 | 70.4 | 40.7 | 11.8 | 83.7 | 56.4 | 30.1 | 04.8 | 80.4 | 57.2 | 21 |
| 22 | 02.0 | 71.5 | 41.8 | 12.9 | 84.9 | 57.7 | 31.4 | 06.0 | 81.7 | 58.5 | 22 |
| 23 | 03.1 | 72.7 | 43.0 | 14.1 | 86.1 | 58.9 | 32.6 | 07.3 | 83.0 | 59.8 | 23 |
| 24 | 04.3 | 73.9 | 44.2 | 15.3 | 87.3 | 60.1 | 33.8 | 08.5 | 84.3 | 61.0 | 24 |
| 25 | 1905.5 | 1975.0 | 2045.4 | 2116.5 | 2188.5 | 2261.3 | 2335.1 | 2409.8 | 2485.5 | 2562.3 | 25 |
| 26 | 06.6 | 76.2 | 46.6 | 17.7 | 89.7 | 62.5 | 36.3 | 11.1 | 86.8 | 63.6 | 26 |
| 27 | 07.8 | 77.4 | 47.7 | 18.9 | 90.9 | 63.8 | 37.6 | 12.3 | 88.1 | 64.9 | 27 |
| 28 | 08.9 | 78.5 | 48.9 | 20.1 | 92.1 | 65.0 | 38.8 | 13.6 | 89.3 | 66.2 | 28 |
| 29 | 10.1 | 79.7 | 50.1 | 21.3 | 93.3 | 66.2 | 40.0 | 14.8 | 90.6 | 67.5 | 29 |
| 30 | 1911.2 | 1980.9 | 2051.3 | 2122.5 | 2194.5 | 2267.4 | 2341.3 | 2416.1 | 2491.9 | 2568.8 | 30 |
| 31 | 12.4 | 82.0 | 52.5 | 23.7 | 95.7 | 68.7 | 42.5 | 17.3 | 93.2 | 70.1 | 31 |
| 32 | 13.5 | 83.2 | 53.6 | 24.9 | 96.9 | 69.9 | 43.7 | 18.6 | 94.4 | 71.4 | 32 |
| 33 | 14.7 | 84.4 | 54.8 | 26.1 | 98.1 | 71.1 | 45.0 | 19.8 | 95.7 | 72.7 | 33 |
| 34 | 15.8 | 85.5 | 56.0 | 27.3 | 99.4 | 72.3 | 46.2 | 21.1 | 97.0 | 73.9 | 34 |
| 35 | 1917.0 | 1986.7 | 2057.2 | 2128.5 | 2200.6 | 2273.5 | 2347.5 | 2422.3 | 2498.3 | 2575.2 | 35 |
| 36 | 18.2 | 87.9 | 58.4 | 29.6 | 01.8 | 74.8 | 48.7 | 23.6 | 99.5 | 76.5 | 36 |
| 37 | 19.3 | 89.1 | 59.5 | 30.8 | 03.0 | 76.0 | 49.9 | 24.9 | 2500.8 | 77.8 | 37 |
| 38 | 20.5 | 90.2 | 60.7 | 32.0 | 04.2 | 77.2 | 51.2 | 26.1 | 02.1 | 79.1 | 38 |
| 39 | 21.6 | 91.4 | 61.9 | 33.2 | 05.4 | 78.4 | 52.4 | 27.4 | 03.4 | 80.4 | 39 |
| 40 | 1922.8 | 1992.6 | 2063.1 | 2134.4 | 2206.6 | 2279.7 | 2353.7 | 2428.6 | 2504.6 | 2581.7 | 40 |
| 41 | 23.9 | 93.7 | 64.3 | 35.6 | 07.8 | 80.9 | 54.9 | 29.9 | 05.9 | 83.0 | 41 |
| 42 | 25.1 | 94.9 | 65.5 | 36.8 | 09.0 | 82.1 | 56.1 | 31.2 | 07.2 | 84.3 | 42 |
| 43 | 26.3 | 96.1 | 66.6 | 38.0 | 10.2 | 83.3 | 57.4 | 32.4 | 08.5 | 85.6 | 43 |
| 44 | 27.4 | 97.2 | 67.8 | 39.2 | 11.5 | 84.6 | 58.6 | 33.7 | 09.7 | 86.9 | 44 |
| 45 | 1928.6 | 1998.4 | 2069.0 | 2140.4 | 2212.7 | 2285.8 | 2359.9 | 2434.9 | 2511.0 | 2588.2 | 45 |
| 46 | 29.7 | 99.6 | 70.2 | 41.6 | 13.9 | 87.0 | 61.1 | 36.2 | 12.3 | 89.5 | 46 |
| 47 | 30.9 | 2000.7 | 71.4 | 42.8 | 15.1 | 88.3 | 62.4 | 37.4 | 13.6 | 90.8 | 47 |
| 48 | 32.0 | 01.9 | 72.6 | 44.0 | 16.3 | 89.5 | 63.6 | 38.7 | 14.8 | 92.1 | 48 |
| 49 | 33.2 | 03.1 | 73.7 | 45.2 | 17.5 | 90.7 | 64.8 | 40.0 | 16.1 | 93.4 | 49 |
| 50 | 1934.4 | 2004.3 | 2074.9 | 2146.4 | 2218.7 | 2291.9 | 2366.1 | 2441.2 | 2517.4 | 2594.7 | 50 |
| 51 | 35.5 | 05.4 | 76.1 | 47.6 | 19.9 | 93.2 | 67.3 | 42.5 | 18.7 | 96.0 | 51 |
| 52 | 36.7 | 06.6 | 77.3 | 48.8 | 21.1 | 94.4 | 68.6 | 43.7 | 20.0 | 97.3 | 52 |
| 53 | 37.8 | 07.8 | 78.5 | 50.0 | 22.4 | 95.6 | 69.8 | 45.0 | 21.2 | 98.5 | 53 |
| 54 | 39.0 | 08.9 | 79.7 | 51.2 | 23.6 | 96.9 | 71.1 | 46.3 | 22.5 | 99.8 | 54 |
| 55 | 1940.2 | 2010.1 | 2080.8 | 2152.4 | 2224.8 | 2298.1 | 2372.3 | 2447.5 | 2523.8 | 2601.1 | 55 |
| 56 | 41.3 | 11.3 | 82.0 | 53.6 | 26.0 | 99.3 | 73.6 | 48.8 | 25.1 | 02.4 | 56 |
| 57 | 42.5 | 12.5 | 83.2 | 54.8 | 27.2 | 2300.5 | 74.8 | 50.1 | 26.4 | 03.7 | 57 |
| 58 | 43.6 | 13.6 | 84.4 | 56.0 | 28.4 | 01.8 | 76.1 | 51.3 | 27.6 | 05.0 | 58 |
| 59 | 44.8 | 14.8 | 85.6 | 57.2 | 29.6 | 03.0 | 77.3 | 52.3 | 28.9 | 06.3 | 59 |
| M. | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° | 39° | M. |

# TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

| M. | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | M. |
|----|------|------|------|------|------|------|------|------|------|------|----|
| 0 | 2607.6 | 2686.2 | 2766.0 | 2847.1 | 2929.5 | 3013.4 | 3098.7 | 3185.6 | 3274.1 | 3364.4 | 0 |
| 1 | 08.9 | 87.6 | 67.4 | 48.5 | 30.9 | 14.8 | 3100.1 | 87.1 | 75.6 | 65.9 | 1 |
| 2 | 10.2 | 88.9 | 68.7 | 49.9 | 32.3 | 16.2 | 01.6 | 88.5 | 77.1 | 67.4 | 2 |
| 3 | 11.5 | 90.2 | 70.1 | 51.2 | 33.7 | 17.6 | 03.0 | 90.0 | 78.6 | 69.0 | 3 |
| 4 | 12.8 | 91.5 | 71.4 | 52.6 | 35.1 | 19.0 | 04.4 | 91.4 | 80.1 | 70.5 | 4 |
| 5 | 2614.1 | 2692.8 | 2772.8 | 2853.9 | 2936.5 | 3020.4 | 3105.9 | 3192.9 | 3281.6 | 3372.0 | 5 |
| 6 | 15.4 | 94.2 | 74.1 | 55.3 | 37.9 | 21.8 | 07.3 | 94.4 | 83.1 | 73.5 | 6 |
| 7 | 16.8 | 95.5 | 75.4 | 56.7 | 39.3 | 23.3 | 08.8 | 95.8 | 84.6 | 75.1 | 7 |
| 8 | 18.1 | 96.8 | 76.8 | 58.0 | 40.6 | 24.7 | 10.2 | 97.3 | 86.1 | 76.6 | 8 |
| 9 | 19.4 | 98.1 | 78.1 | 59.4 | 42.0 | 26.1 | 11.6 | 98.8 | 87.6 | 78.1 | 9 |
| 10 | 2620.7 | 2699.5 | 2779.5 | 2860.8 | 2943.4 | 3027.5 | 3113.1 | 3200.2 | 3289.0 | 3379.6 | 10 |
| 11 | 22.0 | 2700.8 | 80.8 | 62.1 | 44.8 | 28.9 | 14.5 | 01.7 | 90.5 | 81.2 | 11 |
| 12 | 23.3 | 02.1 | 82.2 | 63.5 | 46.2 | 30.3 | 16.0 | 03.2 | 92.0 | 82.7 | 12 |
| 13 | 24.6 | 03.4 | 83.5 | 64.9 | 47.6 | 31.7 | 17.4 | 04.6 | 93.5 | 84.2 | 13 |
| 14 | 25.9 | 04.8 | 84.8 | 66.2 | 49.0 | 33.2 | 18.8 | 06.1 | 95.0 | 85.7 | 14 |
| 15 | 2627.2 | 2706.1 | 2786.2 | 2867.6 | 2950.4 | 3034.6 | 3120.3 | 3207.6 | 3296.5 | 3387.3 | 15 |
| 16 | 28.5 | 07.4 | 87.5 | 69.0 | 51.8 | 36.0 | 21.7 | 09.0 | 98.0 | 88.8 | 16 |
| 17 | 29.8 | 08.7 | 88.9 | 70.3 | 53.2 | 37.4 | 23.2 | 10.5 | 99.5 | 90.3 | 17 |
| 18 | 31.1 | 10.1 | 90.2 | 71.7 | 54.5 | 38.8 | 24.6 | 12.0 | 3301.0 | 91.8 | 18 |
| 19 | 32.4 | 11.4 | 91.6 | 73.1 | 55.9 | 40.2 | 26.0 | 13.4 | 02.5 | 93.4 | 19 |
| 20 | 2633.7 | 2712.7 | 2792.9 | 2874.4 | 2957.3 | 3041.7 | 3127.5 | 3214.9 | 3304.0 | 3394.9 | 20 |
| 21 | 35.0 | 14.0 | 94.3 | 75.8 | 58.7 | 43.1 | 28.9 | 16.4 | 05.5 | 96.4 | 21 |
| 22 | 36.3 | 15.4 | 95.6 | 77.2 | 60.1 | 44.5 | 30.4 | 17.9 | 07.0 | 98.0 | 22 |
| 23 | 37.6 | 16.7 | 97.0 | 78.6 | 61.5 | 45.9 | 31.8 | 19.3 | 08.5 | 99.5 | 23 |
| 24 | 38.9 | 18.0 | 98.3 | 79.9 | 62.9 | 47.3 | 33.3 | 20.8 | 10.0 | 3401.0 | 24 |
| 25 | 2640.2 | 2719.3 | 2799.7 | 2881.3 | 2964.3 | 3048.7 | 3134.7 | 3222.3 | 3311.5 | 3402.6 | 25 |
| 26 | 41.6 | 20.7 | 2801.0 | 82.7 | 65.7 | 50.2 | 36.2 | 23.7 | 13.0 | 04.1 | 26 |
| 27 | 42.9 | 22.0 | 02.4 | 84.0 | 67.1 | 51.6 | 37.6 | 25.2 | 14.5 | 05.6 | 27 |
| 28 | 44.2 | 23.3 | 03.7 | 85.4 | 68.5 | 53.0 | 39.0 | 26.7 | 16.0 | 07.2 | 28 |
| 29 | 45.5 | 24.7 | 05.1 | 86.8 | 69.9 | 54.4 | 40.5 | 28.2 | 17.5 | 08.7 | 29 |
| 30 | 2646.8 | 2726.0 | 2806.4 | 2888.2 | 2971.3 | 3055.9 | 3141.9 | 3229.6 | 3319.0 | 3410.2 | 30 |
| 31 | 48.1 | 27.3 | 07.8 | 89.5 | 72.7 | 57.3 | 43.4 | 31.1 | 20.5 | 11.8 | 31 |
| 32 | 49.4 | 28.6 | 09.1 | 90.9 | 74.1 | 58.7 | 44.8 | 32.6 | 22.1 | 13.3 | 32 |
| 33 | 50.7 | 30.0 | 10.5 | 92.3 | 75.5 | 60.1 | 46.3 | 34.1 | 23.6 | 14.8 | 33 |
| 34 | 52.0 | 31.3 | 11.8 | 93.7 | 76.9 | 61.5 | 47.7 | 35.6 | 25.1 | 16.4 | 34 |
| 35 | 2653.3 | 2732.6 | 2813.2 | 2895.0 | 2978.3 | 3063.0 | 3149.2 | 3237.0 | 3326.6 | 3417.9 | 35 |
| 36 | 54.7 | 34.0 | 14.5 | 96.4 | 79.7 | 64.4 | 50.6 | 38.5 | 28.1 | 19.5 | 36 |
| 37 | 56.0 | 35.3 | 15.9 | 97.8 | 81.1 | 65.8 | 52.1 | 40.0 | 29.6 | 21.0 | 37 |
| 38 | 57.3 | 36.6 | 17.2 | 99.2 | 82.5 | 67.2 | 53.5 | 41.5 | 31.1 | 22.5 | 38 |
| 39 | 58.6 | 38.0 | 18.6 | 2900.5 | 83.9 | 68.7 | 55.0 | 42.9 | 32.6 | 24.1 | 39 |
| 40 | 2659.9 | 2739.3 | 2820.0 | 2901.9 | 2985.3 | 3070.1 | 3156.4 | 3244.4 | 3334.1 | 3425.6 | 40 |
| 41 | 61.2 | 40.6 | 21.3 | 03.3 | 86.7 | 71.5 | 57.9 | 45.9 | 35.6 | 27.2 | 41 |
| 42 | 62.5 | 42.0 | 22.7 | 04.7 | 88.1 | 72.9 | 59.4 | 47.4 | 37.1 | 28.7 | 42 |
| 43 | 63.9 | 43.3 | 24.0 | 06.1 | 89.5 | 74.4 | 60.8 | 48.9 | 38.6 | 30.2 | 43 |
| 44 | 65.2 | 44.6 | 25.4 | 07.4 | 90.9 | 75.8 | 62.3 | 50.3 | 40.2 | 31.8 | 44 |
| 45 | 2666.5 | 2746.0 | 2826.7 | 2908.8 | 2992.3 | 3077.2 | 3163.7 | 3251.8 | 3341.7 | 3433.3 | 45 |
| 46 | 67.8 | 47.3 | 28.1 | 10.2 | 93.7 | 78.7 | 65.2 | 53.3 | 43.2 | 34.9 | 46 |
| 47 | 69.1 | 48.6 | 29.4 | 11.6 | 95.1 | 80.1 | 66.6 | 54.8 | 44.7 | 36.4 | 47 |
| 48 | 70.4 | 50.0 | 30.8 | 13.0 | 96.5 | 81.5 | 68.1 | 56.3 | 46.2 | 38.0 | 48 |
| 49 | 71.7 | 51.3 | 32.2 | 14.3 | 97.9 | 82.9 | 69.5 | 57.8 | 47.7 | 39.5 | 49 |
| 50 | 2673.1 | 2752.7 | 2833.5 | 2915.7 | 2999.3 | 3084.4 | 3171.0 | 3259.3 | 3349.2 | 3441.0 | 50 |
| 51 | 74.4 | 54.0 | 34.9 | 17.1 | 3000.7 | 85.8 | 72.5 | 60.7 | 50.8 | 42.6 | 51 |
| 52 | 75.7 | 55.3 | 36.2 | 18.5 | 02.1 | 87.2 | 73.9 | 62.2 | 52.3 | 44.1 | 52 |
| 53 | 77.0 | 56.7 | 37.6 | 19.9 | 03.5 | 88.7 | 75.4 | 63.7 | 53.8 | 45.7 | 53 |
| 54 | 78.3 | 58.0 | 39.0 | 21.2 | 04.9 | 90.1 | 76.8 | 65.2 | 55.3 | 47.2 | 54 |
| 55 | 2679.6 | 2759.3 | 2840.3 | 2922.6 | 3006.3 | 3091.5 | 3178.3 | 3266.7 | 3356.8 | 3448.8 | 55 |
| 56 | 81.0 | 60.7 | 41.7 | 24.0 | 07.7 | 93.0 | 79.7 | 68.2 | 58.3 | 50.3 | 56 |
| 57 | 82.3 | 62.0 | 43.0 | 25.4 | 09.2 | 94.4 | 81.2 | 69.7 | 59.9 | 51.9 | 57 |
| 58 | 83.6 | 63.4 | 44.4 | 26.8 | 10.6 | 95.8 | 82.7 | 71.1 | 61.4 | 53.4 | 58 |
| 59 | 84.9 | 64.7 | 45.8 | 28.2 | 12.0 | 97.3 | 84.1 | 72.6 | 62.9 | 55.0 | 59 |
| M. | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | M. |

TABLE 3. [Page 463

Meridional Parts, or Increased Latitudes.

Comp. $\dfrac{1}{293.465}$

| M. | 50° | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 3456.5 | 3550.6 | 3646.7 | 3745.1 | 3845.7 | 3948.8 | 4054.5 | 4163.0 | 4274.4 | 4389.1 | 0 |
| 1 | 58.1 | 52.2 | 48.4 | 46.7 | 47.4 | 50.5 | 56.3 | 64.8 | 76.3 | 91.0 | 1 |
| 2 | 59.6 | 53.8 | 50.0 | 48.4 | 49.1 | 52.3 | 58.1 | 66.6 | 78.2 | 92.9 | 2 |
| 3 | 61.2 | 55.4 | 51.6 | 50.0 | 50.8 | 54.0 | 59.8 | 68.5 | 80.1 | 94.9 | 3 |
| 4 | 62.7 | 56.9 | 53.2 | 51.7 | 52.5 | 55.7 | 61.6 | 70.3 | 82.0 | 96.8 | 4 |
| 5 | 3464.3 | 3558.5 | 3654.8 | 3753.4 | 3854.2 | 3957.5 | 4063.4 | 4172.1 | 4283.9 | 4398.8 | 5 |
| 6 | 65.9 | 60.1 | 56.5 | 55.0 | 55.9 | 59.2 | 65.2 | 74.0 | 85.7 | 4400.7 | 6 |
| 7 | 67.4 | 61.7 | 58.1 | 56.7 | 57.6 | 61.0 | 67.0 | 75.8 | 87.6 | 02.6 | 7 |
| 8 | 69.0 | 63.3 | 59.7 | 58.3 | 59.3 | 62.7 | 68.8 | 77.7 | 89.5 | 04.6 | 8 |
| 9 | 70.5 | 64.9 | 61.3 | 60.0 | 61.0 | 64.5 | 70.6 | 79.5 | 91.4 | 06.5 | 9 |
| 10 | 3472.1 | 3566.5 | 3663.0 | 3761.7 | 3862.7 | 3966.2 | 4072.4 | 4181.3 | 4293.3 | 4408.5 | 10 |
| 11 | 73.6 | 68.1 | 64.6 | 63.3 | 64.4 | 68.0 | 74.2 | 83.2 | 95.2 | 10.4 | 11 |
| 12 | 75.2 | 69.7 | 66.2 | 65.0 | 66.1 | 69.7 | 76.0 | 85.0 | 97.1 | 12.4 | 12 |
| 13 | 76.7 | 71.3 | 67.9 | 66.7 | 67.8 | 71.5 | 77.7 | 86.9 | 99.0 | 14.3 | 13 |
| 14 | 78.3 | 72.8 | 69.5 | 68.3 | 69.5 | 73.2 | 79.5 | 88.7 | 4300.9 | 16.3 | 14 |
| 15 | 3479.9 | 3574.4 | 3671.1 | 3770.0 | 3871.2 | 3975.9 | 4081.3 | 4190.6 | 4302.8 | 4418.2 | 15 |
| 16 | 81.4 | 76.0 | 72.7 | 71.7 | 72.9 | 76.7 | 83.1 | 92.4 | 04.7 | 20.2 | 16 |
| 17 | 83.0 | 77.6 | 74.4 | 73.3 | 74.6 | 78.5 | 84.9 | 94.2 | 06.6 | 22.1 | 17 |
| 18 | 84.5 | 79.2 | 76.0 | 75.0 | 76.3 | 80.2 | 86.7 | 96.1 | 08.5 | 24.1 | 18 |
| 19 | 86.1 | 80.8 | 77.6 | 76.7 | 78.1 | 82.0 | 88.5 | 97.9 | 10.4 | 26.1 | 19 |
| 20 | 3487.7 | 3582.4 | 3679.3 | 3778.3 | 3879.8 | 3983.7 | 4090.3 | 4199.8 | 4312.3 | 4428.0 | 20 |
| 21 | 89.2 | 84.0 | 80.9 | 80.0 | 81.5 | 85.5 | 92.1 | 4201.6 | 14.2 | 30.0 | 21 |
| 22 | 90.8 | 85.6 | 82.5 | 81.7 | 83.2 | 87.2 | 93.9 | 03.5 | 16.1 | 31.9 | 22 |
| 23 | 92.4 | 87.2 | 84.2 | 83.3 | 84.9 | 89.0 | 95.7 | 05.3 | 18.0 | 33.9 | 23 |
| 24 | 93.9 | 88.8 | 85.8 | 85.0 | 86.6 | 90.7 | 97.5 | 07.2 | 19.9 | 35.8 | 24 |
| 25 | 3495.5 | 3590.4 | 3687.4 | 3786.7 | 3888.3 | 3992.5 | 4099.3 | 4209.0 | 4321.8 | 4437.8 | 25 |
| 26 | 97.1 | 92.0 | 89.1 | 88.4 | 90.0 | 94.3 | 4101.1 | 10.9 | 23.7 | 39.8 | 26 |
| 27 | 98.6 | 93.6 | 90.7 | 90.0 | 91.8 | 96.0 | 02.9 | 12.8 | 25.6 | 41.7 | 27 |
| 28 | 3500.2 | 95.2 | 92.3 | 91.7 | 93.5 | 97.8 | 04.8 | 14.6 | 27.5 | 43.7 | 28 |
| 29 | 01.8 | 96.8 | 94.0 | 93.4 | 95.2 | 99.5 | 06.6 | 16.5 | 29.4 | 45.7 | 29 |
| 30 | 3503.3 | 3598.4 | 3695.6 | 3795.1 | 3896.9 | 4001.3 | 4108.4 | 4218.3 | 4331.3 | 4447.6 | 30 |
| 31 | 04.9 | 3600.0 | 97.3 | 96.8 | 98.6 | 03.1 | 10.2 | 20.2 | 33.2 | 49.6 | 31 |
| 32 | 06.5 | 01.6 | 98.9 | 98.4 | 3900.4 | 04.8 | 12.0 | 22.0 | 35.2 | 51.6 | 32 |
| 33 | 08.0 | 03.2 | 3700.5 | 3800.1 | 02.1 | 06.6 | 13.8 | 23.9 | 37.1 | 53.5 | 33 |
| 34 | 09.6 | 04.8 | 02.2 | 01.8 | 03.8 | 08.3 | 15.6 | 25.8 | 39.0 | 55.5 | 34 |
| 35 | 3511.2 | 3606.4 | 3703.8 | 3803.5 | 3905.5 | 4010.1 | 4117.4 | 4227.6 | 4340.9 | 4457.5 | 35 |
| 36 | 12.7 | 08.0 | 05.5 | 05.1 | 07.2 | 11.9 | 19.2 | 29.5 | 42.8 | 59.4 | 36 |
| 37 | 14.3 | 09.6 | 07.1 | 06.8 | 09.0 | 13.6 | 21.0 | 31.3 | 44.7 | 61.4 | 37 |
| 38 | 15.9 | 11.2 | 08.7 | 08.5 | 10.7 | 15.4 | 22.9 | 33.2 | 46.6 | 63.4 | 38 |
| 39 | 17.5 | 12.8 | 10.4 | 10.2 | 12.4 | 17.2 | 24.7 | 35.1 | 48.6 | 65.4 | 39 |
| 40 | 3519.0 | 3614.5 | 3712.0 | 3811.9 | 3914.1 | 4018.9 | 4126.5 | 4236.9 | 4350.5 | 4467.3 | 40 |
| 41 | 20.6 | 16.1 | 13.7 | 13.6 | 15.9 | 20.7 | 28.3 | 38.8 | 52.4 | 69.3 | 41 |
| 42 | 22.2 | 17.7 | 15.3 | 15.2 | 17.6 | 22.5 | 30.1 | 40.7 | 54.3 | 71.3 | 42 |
| 43 | 23.7 | 19.3 | 17.0 | 17.0 | 19.3 | 24.3 | 31.9 | 42.5 | 56.2 | 73.3 | 43 |
| 44 | 25.3 | 20.9 | 18.6 | 18.6 | 21.0 | 26.0 | 33.8 | 44.4 | 58.2 | 75.3 | 44 |
| 45 | 3526.9 | 3622.5 | 3720.3 | 3820.3 | 3922.8 | 4027.8 | 4135.6 | 4246.3 | 4360.1 | 4477.2 | 45 |
| 46 | 28.5 | 24.1 | 21.9 | 22.0 | 24.5 | 29.6 | 37.4 | 48.1 | 62.0 | 79.2 | 46 |
| 47 | 30.1 | 25.7 | 23.6 | 23.7 | 26.2 | 31.4 | 39.2 | 50.0 | 63.9 | 81.2 | 47 |
| 48 | 31.6 | 27.3 | 25.2 | 25.4 | 28.0 | 33.1 | 41.0 | 51.9 | 65.9 | 83.2 | 48 |
| 49 | 33.2 | 29.0 | 26.9 | 27.1 | 29.7 | 34.9 | 42.9 | 53.8 | 67.8 | 85.2 | 49 |
| 50 | 3534.8 | 3630.6 | 3728.5 | 3828.7 | 3931.4 | 4036.7 | 4144.7 | 4255.6 | 4369.7 | 4487.2 | 50 |
| 51 | 36.4 | 32.2 | 30.2 | 30.4 | 33.2 | 38.5 | 46.5 | 57.5 | 71.7 | 89.1 | 51 |
| 52 | 37.9 | 33.8 | 31.8 | 32.1 | 34.9 | 40.2 | 48.3 | 59.4 | 73.6 | 91.1 | 52 |
| 53 | 39.5 | 35.4 | 33.5 | 33.8 | 36.6 | 42.0 | 50.2 | 61.3 | 75.5 | 93.1 | 53 |
| 54 | 41.1 | 37.0 | 35.1 | 35.5 | 38.4 | 43.8 | 52.0 | 63.1 | 77.4 | 95.1 | 54 |
| 55 | 3542.7 | 3638.6 | 3736.8 | 3837.2 | 3940.1 | 4045.6 | 4153.8 | 4265.0 | 4379.4 | 4497.1 | 55 |
| 56 | 44.3 | 40.3 | 38.4 | 38.9 | 41.8 | 47.4 | 55.7 | 66.9 | 81.3 | 99.1 | 56 |
| 57 | 45.9 | 41.9 | 40.1 | 40.6 | 43.6 | 49.1 | 57.5 | 68.8 | 83.2 | 4501.1 | 57 |
| 58 | 47.4 | 43.5 | 41.7 | 42.3 | 45.3 | 50.9 | 59.3 | 70.7 | 85.2 | 03.1 | 58 |
| 59 | 49.0 | 45.1 | 43.4 | 45.0 | 47.0 | 52.7 | 61.1 | 72.5 | 87.1 | 05.1 | 59 |
| M. | 50° | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | M. |

# TABLE 3.

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

| M. | 60° | 61° | 62° | 63° | 64° | 65° | 66° | 67° | 68° | 69° | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4507.1 | 4628.7 | 4754.3 | 4884.1 | 5018.4 | 5157.6 | 5302.1 | 5452.4 | 5609.1 | 5772.7 | 0 |
| 1 | 09.1 | 30.8 | 56.4 | 86.3 | 20.6 | 59.9 | 04.6 | 55.0 | 11.8 | 75.5 | 1 |
| 2 | 11.1 | 32.9 | 58.6 | 88.5 | 22.9 | 62.3 | 07.0 | 57.6 | 14.4 | 78.3 | 2 |
| 3 | 13.1 | 34.9 | 60.7 | 90.7 | 25.2 | 64.7 | 09.5 | 60.1 | 17.1 | 81.1 | 3 |
| 4 | 15.1 | 37.0 | 62.8 | 92.9 | 27.5 | 67.0 | 11.9 | 62.7 | 19.8 | 83.8 | 4 |
| 5 | 4517.1 | 4639.0 | 4764.9 | 4895.1 | 5029.8 | 5169.4 | 5314.4 | 5465.2 | 5622.4 | 5786.6 | 5 |
| 6 | 19.1 | 41.1 | 67.1 | 97.3 | 32.1 | 71.8 | 16.9 | 67.8 | 25.1 | 89.4 | 6 |
| 7 | 21.1 | 43.2 | 69.2 | 99.5 | 34.3 | 74.2 | 19.3 | 70.4 | 27.8 | 92.2 | 7 |
| 8 | 23.1 | 45.2 | 71.3 | 4901.7 | 36.6 | 76.5 | 21.8 | 72.9 | 30.5 | 95.1 | 8 |
| 9 | 25.1 | 47.3 | 73.5 | 03.9 | 38.9 | 78.9 | 24.3 | 75.5 | 33.2 | 97.9 | 9 |
| 10 | 4527.1 | 4649.4 | 4775.6 | 4906.1 | 5041.2 | 5181.3 | 5326.7 | 5477.1 | 5635.9 | 5800.7 | 10 |
| 11 | 29.1 | 51.5 | 77.8 | 08.3 | 43.5 | 83.7 | 29.2 | 80.7 | 38.5 | 03.5 | 11 |
| 12 | 31.1 | 53.5 | 79.9 | 10.5 | 45.8 | 86.0 | 31.7 | 83.2 | 41.2 | 06.3 | 12 |
| 13 | 33.1 | 55.6 | 82.0 | 12.8 | 48.1 | 88.4 | 34.2 | 85.8 | 43.9 | 09.1 | 13 |
| 14 | 35.1 | 57.7 | 84.2 | 15.0 | 50.4 | 90.8 | 36.6 | 88.4 | 46.6 | 11.9 | 14 |
| 15 | 4537.1 | 4659.7 | 4786.3 | 4917.2 | 5052.7 | 5193.2 | 5339.1 | 5491.0 | 5649.3 | 5814.7 | 15 |
| 16 | 39.2 | 61.8 | 88.5 | 19.4 | 55.0 | 95.6 | 41.6 | 93.6 | 52.0 | 17.6 | 16 |
| 17 | 41.2 | 63.9 | 90.6 | 21.6 | 57.3 | 98.0 | 44.1 | 96.2 | 54.7 | 20.4 | 17 |
| 18 | 43.2 | 66.0 | 92.8 | 23.9 | 59.6 | 5200.4 | 46.6 | 98.7 | 57.4 | 23.2 | 18 |
| 19 | 45.2 | 68.1 | 94.9 | 26.1 | 61.9 | 02.7 | 49.1 | 5501.3 | 60.1 | 26.0 | 19 |
| 20 | 4547.2 | 4670.1 | 4797.1 | 4928.3 | 5064.2 | 5205.1 | 5351.5 | 5503.9 | 5662.8 | 5828.9 | 20 |
| 21 | 49.2 | 72.2 | 99.2 | 30.5 | 66.5 | 07.5 | 54.0 | 06.5 | 65.5 | 31.7 | 21 |
| 22 | 51.3 | 74.3 | 4801.4 | 32.8 | 68.8 | 09.9 | 56.5 | 09.1 | 68.2 | 34.5 | 22 |
| 23 | 53.3 | 76.4 | 03.5 | 35.0 | 71.1 | 12.3 | 59.0 | 11.7 | 70.9 | 37.4 | 23 |
| 24 | 55.3 | 78.5 | 05.7 | 37.2 | 73.4 | 14.7 | 61.5 | 14.3 | 73.7 | 40.2 | 24 |
| 25 | 4557.3 | 4680.6 | 4807.8 | 4939.4 | 5075.7 | 5217.1 | 5364.0 | 5516.9 | 5676.4 | 5843.0 | 25 |
| 26 | 59.3 | 82.6 | 10.0 | 41.7 | 78.1 | 19.5 | 66.5 | 19.5 | 79.1 | 45.9 | 26 |
| 27 | 61.4 | 84.7 | 12.1 | 43.9 | 80.4 | 21.9 | 69.0 | 22.1 | 81.8 | 48.7 | 27 |
| 28 | 63.4 | 86.8 | 14.3 | 46.1 | 82.7 | 24.3 | 71.5 | 24.7 | 84.5 | 51.6 | 28 |
| 29 | 65.4 | 88.9 | 16.5 | 48.4 | 85.0 | 26.7 | 74.0 | 27.3 | 87.3 | 54.4 | 29 |
| 30 | 4567.4 | 4691.0 | 4818.6 | 4950.6 | 5087.3 | 5229.1 | 5376.5 | 5529.9 | 5690.0 | 5857.3 | 30 |
| 31 | 69.5 | 93.1 | 20.8 | 52.9 | 89.6 | ·31.6 | 79.0 | 32.5 | 92.7 | 60.1 | 31 |
| 32 | 71.5 | 95.2 | 23.0 | 55.1 | 92.0 | 34.0 | 81.5 | 35.2 | 95.4 | 63.0 | 32 |
| 33 | 73.5 | 97.3 | 25.1 | 57.3 | 94.3 | 36.4 | 84.0 | 37.8 | 98.2 | 65.9 | 33 |
| 34 | 75.6 | 99.4 | 27.3 | 59.6 | 96.6 | 38.8 | 86.5 | 40.4 | 5700.9 | 68.7 | 34 |
| 35 | 4577.6 | 4701.5 | 4829.5 | 4961.8 | 5098.9 | 5241.2 | 5389.1 | 5543.0 | 5703.6 | 5871.6 | 35 |
| 36 | 79.6 | 03.6 | 31.6 | 64.1 | 5101.3 | 43.6 | 91.6 | 45.6 | 06.4 | 74.4 | 36 |
| 37 | 81.7 | 05.7 | 33.8 | 66.3 | 03.6 | 46.0 | 94.1 | 48.3 | 09.1 | 77.3 | 37 |
| 38 | 83.7 | 07.8 | 36.0 | 68.6 | 05.9 | 48.5 | 96.6 | 50.9 | 11.9 | 80.2 | 38 |
| 39 | 85.7 | 09.9 | 38.1 | 70.8 | 08.3 | 50.9 | 99.1 | 53.5 | 14.6 | 83.1 | 39 |
| 40 | 4587.8 | 4712.0 | 4840.3 | 4973.1 | 5110.6 | 5253.3 | 5401.6 | 5556.1 | 5717.3 | 5885.9 | 40 |
| 41 | 89.8 | 14.1 | 42.5 | 75.3 | 12.9 | 55.7 | 04.2 | 58.8 | 20.1 | 88.8 | 41 |
| 42 | 91.8 | 16.2 | 44.7 | 77.6 | 15.3 | 58.2 | 06.7 | 61.4 | 22.8 | 91.7 | 42 |
| 43 | 93.9 | 18.3 | 46.8 | 79.8 | 17.6 | 60.6 | 09.2 | 64.0 | 25.6 | 94.6 | 43 |
| 44 | 95.9 | 20.4 | 49.0 | 82.1 | 19.9 | 63.0 | 11.8 | 66.7 | 28.3 | 97.4 | 44 |
| 45 | 4598.0 | 4722.5 | 4851.2 | 4984.3 | 5122.3 | 5265.4 | 5414.3 | 5569.3 | 5731.1 | 5900.3 | 45 |
| 46 | 4600.0 | 24.6 | 53.4 | 86.6 | 24.6 | 67.9 | 16.8 | 71.9 | 33.9 | 03.2 | 46 |
| 47 | 02.1 | 26.7 | 55.6 | 88.9 | 27.0 | 70.3 | 19.3 | 74.6 | 36.6 | 06.1 | 47 |
| 48 | 04.1 | ·28.9 | 57.8 | 91.1 | 29.3 | 72.8 | 21.9 | 77.2 | 39.4 | 09.0 | 48 |
| 49 | 06.1 | 31.0 | 59.9 | 93.4 | 31.7 | 75.2 | 24.4 | 79.9 | 42.1 | 11.9 | 49 |
| 50 | 4608.2 | 4733.1 | 4862.1 | 4995.6 | 5134.0 | 5277.6 | 5427.0 | 5582.5 | 5744.9 | 5914.8 | 50 |
| 51 | 10.2 | 35.2 | 64.3 | 97.9 | 36.4 | 80.1 | 29.5 | 85.2 | 47.7 | 17.7 | 51 |
| 52 | 12.3 | 37.3 | 66.5 | 5000.2 | 38.7 | 82.5 | 32.0 | 87.8 | 50.4 | 20.6 | 52 |
| 53 | 14.3 | 39.4 | 68.7 | 02.4 | 41.1 | 85.0 | 34.6 | 90.5 | 53.2 | 23.5 | 53 |
| 54 | 16.4 | 41.6 | 70.9 | 04.7 | 43.4 | 87.4 | 37.1 | 93.1 | 56.0 | 26.4 | 54 |
| 55 | 4618.5 | 4743.7 | 4873.1 | 5007.0 | 5145.8 | 5289.8 | 5439.7 | 5595.8 | 5758.8 | 5929.3 | 55 |
| 56 | 20.5 | 45.8 | 75.3 | 09.3 | 48.1 | 92.3 | 42.2 | 98.4 | 61.5 | 32.2 | 56 |
| 57 | 22.6 | 47.9 | 77.5 | 11.5 | 50.5 | 94.7 | 44.8 | 5601.1 | 64.3 | 35.1 | 57 |
| 58 | 24.6 | 50.0 | 79.7 | 13.8 | 52.8 | 97.2 | 47.3 | 03.8 | 67.1 | 38.1 | 58 |
| 59 | 26.7 | 52.2 | 81.9 | 16.1 | 55.2 | 99.7 | 49.9 | 06.4 | 69.9 | 41.0 | 59 |
| M. | 60° | 61° | 62° | 63° | 64° | 65° | 66° | 67° | 68° | 69° | M. |

TABLE 3. [Page 465

Meridional Parts, or Increased Latitudes.

Comp. $\frac{1}{293.465}$

| M. | 70° | 71° | 72° | 73° | 74° | 75° | 76° | 77° | 78° | 79° | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 5943.9 | 6123.5 | 6312.5 | 6512.0 | 6723.2 | 6947.7 | 7187.3 | 7444.4 | 7721.6 | 8022.7 | 0 |
| 1 | 46.8 | 26.6 | 15.8 | 15.4 | 26.8 | 51.6 | 91.5 | 48.8 | 26.4 | 27.9 | 1 |
| 2 | 49.7 | 29.7 | 19.0 | 18.9 | 30.5 | 55.4 | 95.6 | 53.3 | 31.3 | 33.2 | 2 |
| 3 | 52.7 | 32.8 | 22.3 | 22.3 | 34.1 | 59.3 | 99.7 | 57.7 | 36.1 | 38.5 | 3 |
| 4 | 55.6 | 35.8 | 25.5 | 25.7 | 37.7 | 63.2 | 7203.9 | 62.2 | 40.9 | 43.7 | 4 |
| 5 | 5958.5 | 6138.9 | 6328.8 | 6529.1 | 6741.4 | 6967.1 | 7208.0 | 7466.7 | 7745.8 | 8049.0 | 5 |
| 6 | 61.5 | 42.0 | 32.0 | 32.6 | 45.0 | 70.9 | 12.2 | 71.1 | 50.6 | 54.3 | 6 |
| 7 | 64.4 | 45.1 | 35.3 | 36.0 | 48.7 | 74.8 | 16.4 | 75.6 | 55.5 | 59.6 | 7 |
| 8 | 67.3 | 48.2 | 38.5 | 39.5 | 52.3 | 78.7 | 20.5 | 80.1 | 60.3 | 64.9 | 8 |
| 9 | 70.3 | 51.3 | 41.8 | 42.9 | 56.0 | 82.6 | 24.7 | 84.6 | 65.2 | 70.2 | 9 |
| 10 | 5973.2 | 6154.4 | 6345.0 | 6546.4 | 6759.7 | 6986.5 | 7228.9 | 7489.1 | 7770.1 | 8075.5 | 10 |
| 11 | 76.2 | 57.5 | 48.3 | 49.8 | 63.3 | 90.4 | 33.1 | 93.6 | 74.9 | 80.8 | 11 |
| 12 | 79.1 | 60.6 | 51.6 | 53.3 | 67.0 | 94.3 | 37.3 | 98.1 | 79.8 | 86.1 | 12 |
| 13 | 82.1 | 63.7 | 54.8 | 56.7 | 70.7 | 98.3 | 41.5 | 7502.6 | 84.7 | 91.5 | 13 |
| 14 | 85.0 | 66.8 | 58.1 | 60.2 | 74.3 | 7002.2 | 45.7 | 07.1 | 89.6 | 96.8 | 14 |
| 15 | 5988.0 | 6169.9 | 6361.4 | 6563.7 | 6778.0 | 7006.1 | 7249.9 | 7511.7 | 7794.5 | 8102.2 | 15 |
| 16 | 90.9 | 73.0 | 64.7 | 67.1 | 81.7 | 10.0 | 54.1 | 16.2 | 07.5 | 07.5 | 16 |
| 17 | 93.9 | 76.1 | 67.9 | 70.6 | 85.4 | 14.0 | 58.3 | 20.7 | 7804.3 | 12.9 | 17 |
| 18 | 96.9 | 79.2 | 71.2 | 74.1 | 89.1 | 17.9 | 62.5 | 25.3 | 09.3 | 18.3 | 18 |
| 19 | 99.8 | 82.3 | 74.5 | 77.6 | 92.8 | 21.8 | 66.7 | 29.8 | 14.2 | 23.7 | 19 |
| 20 | 6002.8 | 6185.5 | 6377.8 | 6581.0 | 6796.5 | 7025.8 | 7270.9 | 7534.4 | 7819.1 | 8129.1 | 20 |
| 21 | 05.8 | 88.6 | 81.1 | 84.5 | 6800.2 | 29.7 | 75.2 | 38.9 | 24.1 | 34.5 | 21 |
| 22 | 08.7 | 91.7 | 84.4 | 88.0 | 03.9 | 33.7 | 79.4 | 43.5 | 29.0 | 39.9 | 22 |
| 23 | 11.7 | 94.8 | 87.7 | 91.5 | 07.6 | 37.7 | 83.7 | 48.1 | 34.0 | 45.3 | 23 |
| 24 | 14.7 | 98.0 | 91.0 | 95.0 | 11.3 | 41.6 | 87.9 | 52.7 | 39.0 | 50.8 | 24 |
| 25 | 6017.7 | 6201.1 | 6394.3 | 6598.5 | 6815.0 | 7045.6 | 7292.2 | 7557.3 | 7844.0 | 8156.2 | 25 |
| 26 | 20.7 | 04.2 | 97.6 | 6602.0 | 18.8 | 49.6 | 96.4 | 61.8 | 48.9 | 61.6 | 26 |
| 27 | 23.6 | 07.4 | 6400.9 | 05.5 | 22.5 | 53.5 | 7300.7 | 66.4 | ·53.9 | 67.1 | 27 |
| 28 | 26.6 | 10.5 | 04.3 | 09.0 | 26.2 | 57.5 | 05.0 | 71.0 | 58.9 | 72.6 | 28 |
| 29 | 29.6 | 13.7 | 07.6 | 12.5 | 30.0 | 61.5 | 09.2 | 75.7 | 63.9 | 78.0 | 29 |
| 30 | 6032.6 | 6216.8 | 6410.9 | 6616.1 | 6833.7 | 7065.5 | 7313.5 | 7580.3 | 7868.9 | 8183.5 | 30 |
| 31 | 35.6 | 20.0 | 14.2 | 19.6 | 37.4 | 69.5 | 17.8 | 84.9 | 74.0 | 89.0 | 31 |
| 32 | 38.6 | 23.1 | 17.6 | 23.1 | 41.2 | 73.5 | 22.1 | 89.5 | 79.0 | 94.5 | 32 |
| 33 | 41.6 | 26.3 | 20.9 | 26.6 | 44.9 | 77.5 | 26.4 | 94.2 | 84.0 | 8200.0 | 33 |
| 34 | 44.6 | 29.4 | 24.2 | 30.2 | 48.7 | 81.5 | 30.7 | 98.8 | 89.1 | 05.5 | 34 |
| 35 | 6047.6 | 6232.6 | 6427.6 | 6633.7 | 6852.4 | 7085.5 | 7335.0 | 7603.4 | 7894.1 | 8211.1 | 35 |
| 36 | 50.6 | 35.8 | 30.9 | 37.2 | 56.2 | 89.5 | 39.3 | 08.1 | 99.2 | 16.6 | 36 |
| 37 | 53.6 | 38.9 | 34.2 | 40.8 | 60.0 | 93.5 | 43.6 | 12.8 | 7904.2 | 22.1 | 37 |
| 38 | 56.6 | 42.1 | 37.6 | 44.3 | 63.7 | 97.6 | 47.9 | 17.4 | 09.3 | 27.7 | 38 |
| 39 | 59.7 | 45.3 | 40.9 | 47.9 | 67.5 | 7101.6 | 52.3 | 22.1 | 14.4 | 33.3 | 39 |
| 40 | 6062.7 | 6248.4 | 6444.3 | 6651.4 | 6871.3 | 7105.6 | 7356.6 | 7626.8 | 7919.4 | 8238.8 | 40 |
| 41 | 65.7 | 51.6 | 47.6 | 55.0 | 75.1 | 09.7 | 60.9 | 31.4 | 24.5 | 44.4 | 41 |
| 42 | 68.7 | 54.8 | 51.0 | 58.5 | 78.9 | 13.7 | 65.3 | 36.1 | 29.6 | 50.0 | 42 |
| 43 | 71.7 | 58.0 | 54.4 | 62.1 | 82.6 | 17.8 | 69.6 | 40.8 | 34.7 | 55.6 | 43 |
| 44 | 74.8 | 61.2 | 57.7 | 65.7 | 86.4 | 21.8 | 74.0 | 45.5 | 39.9 | 61.2 | 44 |
| 45 | 6077.8 | 6264.4 | 6461.1 | 6669.2 | 6890.2 | 7125.9 | 7378.3 | 7650.2 | 7945.0 | 8266.8 | 45 |
| 46 | 80.8 | 67.6 | 64.5 | 72.8 | 94.0 | 29.9 | 82.7 | 55.0 | 50.1 | 72.4 | 46 |
| 47 | 83.9 | 70.8 | 67.8 | 76.4 | 97.8 | 34.0 | 87.1 | 59.7 | 55.2 | 78.1 | 47 |
| 48 | 86.9 | 74.0 | 71.2 | 80.0 | 6901.7 | 38.1 | 91.4 | 64.4 | 60.4 | 83.7 | 48 |
| 49 | 89.9 | 77.2 | 74.6 | 83.5 | 05.5 | 42.2 | 95.8 | 69.1 | 65.5 | 89.3 | 49 |
| 50 | 6093.0 | 6280.4 | 6478.0 | 6687.1 | 6909.3 | 7146.2 | 7400.2 | 7673.9 | 7970.7 | 8295.0 | 50 |
| 51 | 96.0 | 83.6 | 81.4 | 90.7 | 13.1 | 50.3 | ·04.6 | 78.6 | 75.9 | 8300.7 | 51 |
| 52 | 99.1 | 86.8 | 84.8 | 94.3 | 16.9 | 54.4 | 09.0 | 83.4 | 81.0 | 06.4 | 52 |
| 53 | 6102.1 | 90.0 | 88.2 | 97.9 | 20.8 | 58.5 | 13.4 | 88.1 | 86.2 | 12.0 | 53 |
| 54 | 05.2 | 93.2 | 91.6 | 6701.5 | 24.6 | 62.6 | 17.8 | 92.9 | 91.4 | 17.7 | 54 |
| 55 | 6108.2 | 6296.4 | 6495.0 | 6705.1 | 6928.4 | 7166.7 | 7422.2 | 7697.7 | 7996.6 | 8323.4 | 55 |
| 56 | 11.3 | 99.6 | 98.4 | 08.7 | 32.3 | 70.8 | 26.6 | 7702.5 | 8001.8 | 29.2 | 56 |
| 57 | 14.3 | 6302.9 | 6501.8 | 12.4 | 36.1 | 75.0 | 31.1 | 07.2 | 07.0 | 34.9 | 57 |
| 58 | 17.4 | 06.1 | 05.2 | 16.0 | 40.0 | 79.1 | 35.5 | 12.0 | 12.2 | 40.6 | 58 |
| 59 | 20.5 | 09.3 | 08.6 | 19.6 | 43.8 | 83.2 | 39.9 | 16.8 | 17.5 | 46.4 | 59 |
| M. | 70° | 71° | 72° | 73° | 74° | 75° | 76° | 77° | 78° | 79° | M. |

# TABLE 4.

## Length of a Degree in Latitude and Longitude.

| Lat. | Degree of Long. | | | Degree of Lat. | | | Lat. |
|---|---|---|---|---|---|---|---|
| | Naut. miles. | Statute miles. | Meters. | Naut. miles. | Statute miles. | Meters. | |
| ° | | | | | | | ° |
| 0 | 60.068 | 69.172 | 111 321 | 59.661 | 68.704 | 110 567 | 0 |
| 1 | 0.059 | 9.162 | 1 304 | .661 | .704 | 568 | 1 |
| 2 | 0.031 | 9.130 | 1 253 | .662 | .705 | 569 | 2 |
| 3 | 59.986 | 9.078 | 1 169 | .663 | .706 | 570 | 3 |
| 4 | 9.922 | 9.005 | 1 051 | .664 | .708 | 573 | 4 |
| 5 | 59.840 | 68.911 | 110 900 | 59.666 | 68.710 | 110 576 | 5 |
| 6 | 9.741 | 8.795 | 0 715 | .668 | .712 | 580 | 6 |
| 7 | 9.622 | 8.660 | 0 497 | .670 | .715 | 584 | 7 |
| 8 | 9.487 | 8.504 | 0 245 | .673 | .718 | 589 | 8 |
| 9 | 9.333 | 8.326 | 109 959 | .676 | .721 | 595 | 9 |
| 10 | 59.161 | 68.129 | 109 641 | 59.680 | 68.725 | 110 601 | 10 |
| 11 | 8.971 | 7.910 | 9 289 | .684 | .730 | 608 | 11 |
| 12 | 8.764 | 7.670 | 8 904 | .687 | .734 | 616 | 12 |
| 13 | 8.538 | 7.410 | 8 486 | .692 | .739 | 624 | 13 |
| 14 | 8.295 | 7.131 | 8 036 | .697 | .744 | 633 | 14 |
| 15 | 58.034 | 66.830 | 107 553 | 59.702 | 68.751 | 110 643 | 15 |
| 16 | 7.756 | 6.510 | 7 036 | .707 | .757 | 653 | 16 |
| 17 | 7.459 | 6.169 | 6 487 | .713 | .764 | 663 | 17 |
| 18 | 7.146 | 5.808 | 5 906 | .719 | .771 | 675 | 18 |
| 19 | 6.816 | 5.427 | 5 294 | .725 | .778 | 686 | 19 |
| 20 | 56.468 | 65.026 | 104 649 | 59.732 | 68.786 | 110 699 | 20 |
| 21 | 6.102 | 4.606 | 3 972 | .739 | .794 | 712 | 21 |
| 22 | 5.720 | 4.166 | 3 264 | .746 | .802 | 725 | 22 |
| 23 | 5.321 | 3.706 | 2 524 | .754 | .811 | 739 | 23 |
| 24 | 4.905 | 3.228 | 1 754 | .761 | .820 | 753 | 24 |
| 25 | 54.473 | 62.729 | 100 952 | 59.769 | 68.829 | 110 768 | 25 |
| 26 | 4.024 | 2.212 | 0 119 | .777 | .839 | 783 | 26 |
| 27 | 3.558 | 1.676 | 99 257 | .786 | .848 | 799 | 27 |
| 28 | 3.076 | 1.122 | 8 364 | .795 | .858 | 815 | 28 |
| 29 | 2.578 | 0.548 | 7 441 | .804 | .869 | 832 | 29 |
| 30 | 52.064 | 59.956 | 96 488 | 59.813 | 68.879 | 110 849 | 30 |
| 31 | 1.534 | 9.345 | 5 506 | .822 | .890 | 866 | 31 |
| 32 | 0.989 | 8.716 | 4 495 | .831 | .901 | 883 | 32 |
| 33 | 0.428 | 8.071 | 3 455 | .841 | .912 | 901 | 33 |
| 34 | 49.851 | 7.407 | 2 387 | .851 | .923 | 919 | 34 |
| 35 | 49.259 | 56.725 | 91 290 | 59.861 | 68.935 | 110 938 | 35 |
| 36 | 8.653 | 6.027 | 0 166 | .871 | .946 | 956 | 36 |
| 37 | 8.031 | 5.311 | 89 014 | .881 | .958 | 975 | 37 |
| 38 | 7.395 | 4.579 | 7 835 | .891 | .969 | 994 | 38 |
| 39 | 6.744 | 3.829 | 6 629 | .902 | .981 | 111 013 | 39 |
| 40 | 46.079 | 53.063 | 85 396 | 59.912 | 68.993 | 111 033 | 40 |
| 41 | 5.399 | 2.281 | 4 137 | .923 | 69.006 | 052 | 41 |
| 42 | 4.706 | 1.483 | 2 853 | .933 | .018 | 072 | 42 |
| 43 | 4.000 | 0.669 | 1 543 | .944 | .030 | 091 | 43 |
| 44 | 3.280 | 49.840 | 0 208 | .954 | .042 | 111 | 44 |
| 45 | 2.546 | 8.995 | 78 849 | .965 | .054 | 131 | 45 |

# TABLE 4.

### Length of a Degree in Latitude and Longitude.

| Lat. | Degree of Long. | | | Degree of Lat. | | | Lat. |
|---|---|---|---|---|---|---|---|
| | Naut. miles. | Statute miles. | Meters. | Naut. miles. | Statute miles. | Meters. | |
| ° | | | | | | | ° |
| 45 | 42.546 | 48.995 | 78 849 | 59.965 | 69.054 | 111 131 | 45 |
| 46 | 1.801 | 8.136 | 7 466 | .976 | .066 | 151 | 46 |
| 47 | 1.041 | 7.261 | 6 058 | .987 | .079 | 170 | 47 |
| 48 | 0.268 | 6.372 | 4 628 | .997 | .091 | 190 | 48 |
| 49 | 39.484 | 5.469 | 3 174 | 60.008 | .103 | 210 | 49 |
| 50 | 38.688 | 44.552 | 71 698 | 60.019 | 69.115 | 111 229 | 50 |
| 51 | 7.880 | 3.621 | 0 200 | .029 | .127 | 249 | 51 |
| 52 | 7.060 | 2.676 | 68 680 | .039 | .139 | 268 | 52 |
| 53 | 6.229 | 1.719 | 7 140 | .050 | .151 | 287 | 53 |
| 54 | 5.386 | 0.749 | 5 578 | .060 | .163 | 306 | 54 |
| 55 | 34.532 | 39.766 | 63 996 | 60.070 | 69.175 | 111 325 | 55 |
| 56 | 3.668 | 8.771 | 2 395 | .080 | .086 | 343 | 56 |
| 57 | 2.794 | 7.764 | 0 774 | .090 | .197 | 362 | 57 |
| 58 | 1.909 | 6.745 | 59 135 | .100 | .209 | 380 | 58 |
| 59 | 1.015 | 5.716 | 7 478 | .109 | .220 | 397 | 59 |
| 60 | 30.110 | 34.674 | 55 802 | 60.118 | 69.230 | 111 415 | 60 |
| 61 | 29.197 | 3.623 | 4 110 | .128 | .241 | 432 | 61 |
| 62 | 8.275 | 2.560 | 2 400 | .137 | .251 | 448 | 62 |
| 63 | 7.344 | 1.488 | 0 675 | .145 | .261 | 464 | 63 |
| 64 | 6.404 | 0.406 | 48 934 | .154 | .271 | 480 | 64 |
| 65 | 25.456 | 29.315 | 47 177 | 60.162 | 69.281 | 111 496 | 65 |
| 66 | 4.501 | 8.215 | 5 407 | .170 | .290 | 511 | 66 |
| 67 | 3.538 | 7.106 | 3 622 | .178 | .299 | 525 | 67 |
| 68 | 2.567 | 5.988 | 1 823 | .186 | .308 | 539 | 68 |
| 69 | 1.590 | 4.862 | 0 012 | .193 | .316 | 553 | 69 |
| 70 | 20.606 | 23.729 | 38 188 | 60.200 | 69.324 | 111 566 | 70 |
| 71 | 19.616 | 2.589 | 6 353 | .207 | .332 | ·578 | 71 |
| 72 | 8.619 | 1.441 | 4 506 | .213 | .340 | 590 | 72 |
| 73 | 7.617 | 0.287 | 2 648 | .220 | .347 | 602 | 73 |
| 74 | 6.609 | 19.127 | 0 781 | .225 | .354 | 613 | 74 |
| 75 | 15.596 | 17.960 | 28 903 | 60.231 | 69.360 | 111 623 | 75 |
| 76 | 4.578 | 6.788 | 7 017 | .236 | .366 | 633 | 76 |
| 77 | 3.556 | 5.611 | 5 123 | .241 | .372 | 642 | 77 |
| 78 | 2.529 | 4.428 | 3 220 | .246 | .377 | 650 | 78 |
| 79 | 1.499 | 3.242 | 1 311 | .250 | .382 | 658 | 79 |
| 80 | 10.465 | 12.051 | 19 394 | 60.254 | 69.386 | 111 665 | 80 |
| 81 | 9.428 | 10.857 | 7 472 | .257 | .390 | 671 | 81 |
| 82 | 8.388 | 9.659 | 5 545 | .260 | .394 | 677 | 82 |
| 83 | 7.345 | 8.458 | 3 612 | .263 | .397 | 682 | 83 |
| 84 | 6.300 | 7.255 | 1 675 | .265 | .400 | 687 | 84 |
| 85 | 5.253 | 6.049 | 9 735 | 60.268 | 69.402 | 111 691 | 85 |
| 86 | 4.205 | 4.842 | 7 792 | .269 | .404 | 694 | 86 |
| 87 | 3.154 | 3.632 | 5 846 | .270 | .405 | 696 | 87 |
| 88 | 2.103 | 2.422 | 3 898 | .271 | .407 | 698 | 88 |
| 89 | 1.052 | 1.211 | 1 949 | .272 | .407 | 699 | 89 |
| 90 | 0 | 0 | 0 | .272 | .407 | 699 | 90 |

# TABLE 5A.

### Distance of an Object by Two Bearings.

| Difference between the course and second bearing, in points. | Difference between the course and first bearing, in points. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | | 2¼ | | 2½ | | 2¾ | | 3 | | 3¼ | | 3½ | |
| 3 | 1.96 | 1.09 | | | | | | | | | | | | |
| 3¼ | 1.57 | 0.94 | 2.19 | 1.31 | | | | | | | | | | |
| 3½ | 1.32 | 0.84 | 1.76 | 1.12 | 2.42 | 1.53 | | | | | | | | |
| 3¾ | 1.14 | 0.76 | 1.47 | 0.99 | 1.94 | 1.30 | 2.64 | 1.77 | | | | | | |
| 4 | 1.00 | 0.71 | 1.27 | 0.90 | 1.62 | 1.15 | 2.12 | 1.50 | 2.85 | 2.01 | | | | |
| 4¼ | 0.90 | 0.66 | 1.12 | 0.83 | 1.40 | 1.04 | 1.77 | 1.31 | 2.29 | 1.69 | 3.05 | 2.26 | | |
| 4½ | 0.81 | 0.63 | 1.00 | 0.77 | 1.23 | 0.95 | 1.53 | 1.18 | 1.91 | 1.48 | 2.45 | 1.90 | 3.25 | 2.51 |
| 4¾ | 0.74 | 0.60 | 0.91 | 0.73 | 1.10 | 0.89 | 1.34 | 1.08 | 1.65 | 1.32 | 2.05 | 1.65 | 2.61 | 2.10 |
| 5 | 0.69 | 0.57 | 0.83 | 0.69 | 1.00 | 0.83 | 1.20 | 1.00 | 1.45 | 1.21 | 1.77 | 1.47 | 2.19 | 1.82 |
| 5¼ | 0.64 | 0.55 | 0.77 | 0.66 | 0.92 | 0.79 | 1.09 | 0.94 | 1.30 | 1.11 | 1.56 | 1.34 | 1.88 | 1.62 |
| 5½ | 0.60 | 0.53 | 0.72 | 0.63 | 0.85 | 0.75 | 1.00 | 0.88 | 1.18 | 1.04 | 1.39 | 1.23 | 1.66 | 1.46 |
| 5¾ | 0.57 | 0.52 | 0.68 | 0.61 | 0.79 | 0.72 | 0.93 | 0.84 | 1.08 | 0.98 | 1.26 | 1.14 | 1.48 | 1.34 |
| 6 | 0.54 | 0.50 | 0.64 | 0.59 | 0.74 | 0.69 | 0.86 | 0.80 | 1.00 | 0.92 | 1.16 | 1.07 | 1.35 | 1.24 |
| 6¼ | 0.52 | 0.49 | 0.60 | 0.57 | 0.70 | 0.66 | 0.81 | 0.76 | 0.93 | 0.88 | 1.07 | 1.01 | 1.23 | 1.16 |
| 6½ | 0.50 | 0.47 | 0.58 | 0.55 | 0.67 | 0.64 | 0.77 | 0.73 | 0.88 | 0.84 | 1.00 | 0.96 | 1.14 | 1.09 |
| 6¾ | 0.48 | 0.46 | 0.55 | 0.54 | 0.64 | 0.62 | 0.73 | 0.71 | 0.83 | 0.80 | 0.94 | 0.91 | 1.06 | 1.03 |
| 7 | 0.46 | 0.45 | 0.53 | 0.52 | 0.61 | 0.60 | 0.69 | 0.68 | 0.79 | 0.77 | 0.89 | 0.87 | 1.00 | 0.98 |
| 7¼ | 0.45 | 0.44 | 0.51 | 0.51 | 0.59 | 0.58 | 0.67 | 0.66 | 0.75 | 0.74 | 0.84 | 0.83 | 0.94 | 0.93 |
| 7½ | 0.43 | 0.43 | 0.50 | 0.50 | 0.57 | 0.56 | 0.64 | 0.64 | 0.72 | 0.72 | 0.80 | 0.80 | 0.90 | 0.89 |
| 7¾ | 0.42 | 0.42 | 0.48 | 0.48 | 0.55 | 0.55 | 0.62 | 0.62 | 0.69 | 0.69 | 0.77 | 0.77 | 0.86 | 0.86 |
| 8 | 0.41 | 0.41 | 0.47 | 0.47 | 0.53 | 0.53 | 0.60 | 0.60 | 0.67 | 0.67 | 0.74 | 0.74 | 0.82 | 0.82 |
| 8¼ | 0.41 | 0.41 | 0.46 | 0.46 | 0.52 | 0.52 | 0.58 | 0.58 | 0.65 | 0.65 | 0.72 | 0.72 | 0.79 | 0.79 |
| 8½ | 0.40 | 0.40 | 0.45 | 0.45 | 0.51 | 0.51 | 0.57 | 0.57 | 0.63 | 0.63 | 0.69 | 0.69 | 0.76 | 0.76 |
| 8¾ | 0.39 | 0.39 | 0.45 | 0.44 | 0.50 | 0.50 | 0.56 | 0.55 | 0.61 | 0.61 | 0.68 | 0.67 | 0.74 | 0.73 |
| 9 | 0.39 | 0.38 | 0.44 | 0.43 | 0.49 | 0.48 | 0.55 | 0.54 | 0.60 | 0.59 | 0.66 | 0.65 | 0.72 | 0.71 |
| 9¼ | 0.39 | 0.38 | 0.44 | 0.42 | 0.49 | 0.47 | 0.54 | 0.52 | 0.59 | 0.57 | 0.64 | 0.63 | 0.70 | 0.68 |
| 9½ | 0.38 | 0.37 | 0.43 | 0.41 | 0.48 | 0.46 | 0.53 | 0.51 | 0.58 | 0.56 | 0.63 | 0.61 | 0.69 | 0.66 |
| 9¾ | 0.38 | 0.36 | 0.43 | 0.40 | 0.48 | 0.45 | 0.52 | 0.49 | 0.57 | 0.54 | 0.62 | 0.59 | 0.67 | 0.63 |
| 10 | 0.38 | 0.35 | 0.43 | 0.40 | 0.47 | 0.44 | 0.52 | 0.48 | 0.57 | 0.52 | 0.61 | 0.57 | 0.66 | 0.61 |
| 10¼ | 0.38 | 0.35 | 0.43 | 0.39 | 0.47 | 0.43 | 0.52 | 0.47 | 0.56 | 0.51 | 0.61 | 0.55 | 0.65 | 0.59 |
| 10½ | 0.38 | 0.34 | 0.43 | 0.38 | 0.47 | 0.42 | 0.51 | 0.45 | 0.56 | 0.49 | 0.60 | 0.53 | 0.65 | 0.57 |
| 10¾ | 0.39 | 0.33 | 0.43 | 0.37 | 0.47 | 0.40 | 0.51 | 0.44 | 0.56 | 0.48 | 0.60 | 0.51 | 0.64 | 0.55 |
| 11 | 0.39 | 0.32 | 0.43 | 0.36 | 0.47 | 0.39 | 0.51 | 0.43 | 0.56 | 0.46 | 0.60 | 0.50 | 0.64 | 0.53 |
| 11¼ | 0.39 | 0.31 | 0.44 | 0.35 | 0.48 | 0.38 | 0.52 | 0.41 | 0.56 | 0.45 | 0.60 | 0.48 | 0.64 | 0.51 |
| 11½ | 0.40 | 0.31 | 0.44 | 0.34 | 0.48 | 0.37 | 0.52 | 0.40 | 0.56 | 0.43 | 0.60 | 0.46 | 0.63 | 0.49 |
| 11¾ | 0.41 | 0.30 | 0.45 | 0.33 | 0.49 | 0.36 | 0.52 | 0.39 | 0.56 | 0.42 | 0.60 | 0.44 | 0.64 | 0.47 |
| 12 | 0.41 | 0.29 | 0.45 | 0.32 | 0.49 | 0.35 | 0.53 | 0.37 | 0.57 | 0.40 | 0.60 | 0.43 | 0.64 | 0.45 |
| 12¼ | 0.42 | 0.28 | 0.46 | 0.31 | 0.50 | 0.34 | 0.54 | 0.36 | 0.57 | 0.38 | 0.61 | 0.41 | 0.64 | 0.42 |
| 12½ | 0.43 | 0.28 | 0.47 | 0.30 | 0.51 | 0.32 | 0.55 | 0.35 | 0.58 | 0.37 | 0.61 | 0.39 | 0.65 | 0.41 |
| 12¾ | 0.45 | 0.27 | 0.48 | 0.29 | 0.52 | 0.31 | 0.56 | 0.33 | 0.59 | 0.35 | 0.62 | 0.37 | 0.65 | 0.39 |
| 13 | 0.46 | 0.26 | 0.50 | 0.28 | 0.53 | 0.30 | 0.57 | 0.32 | 0.60 | 0.33 | 0.63 | 0.35 | 0.66 | 0.37 |
| 13¼ | 0.48 | 0.24 | 0.51 | 0.26 | 0.55 | 0.28 | 0.58 | 0.30 | 0.61 | 0.32 | 0.64 | 0.33 | 0.67 | 0.35 |
| 13½ | 0.50 | 0.23 | 0.53 | 0.25 | 0.57 | 0.27 | 0.60 | 0.28 | 0.63 | 0.30 | 0.66 | 0.31 | 0.69 | 0.32 |
| 13¾ | 0.52 | 0.22 | 0.55 | 0.24 | 0.59 | 0.25 | 0.62 | 0.26 | 0.65 | 0.28 | 0.68 | 0.29 | 0.70 | 0.30 |
| 14 | 0.54 | 0.21 | 0.58 | 0.22 | 0.61 | 0.23 | 0.64 | 0.24 | 0.67 | 0.26 | 0.69 | 0.27 | 0.72 | 0.28 |

# TABLE 5A. [Page 469

## Distance of an Object by Two Bearings.

Difference between the course and second bearing, in points.

Difference between the course and first bearing, in points.

| Difference between the course and second bearing, in points. | 3¾ | | 4 | | 4¼ | | 4½ | | 4¾ | | 5 | | 5¼ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4¾ | 3.44 | 2.76 | | | | | | | | | | | | |
| 5 | 2.76 | 2.30 | 3.62 | 3.01 | | | | | | | | | | |
| 5¼ | 2.31 | 1.98 | 2.91 | 2.50 | 3.80 | 3.26 | | | | | | | | |
| 5½ | 1.99 | 1.76 | 2.44 | 2.15 | 3.05 | 2.69 | 3.96 | 3.49 | | | | | | |
| 5¾ | 1.75 | 1.59 | 2.10 | 1.90 | 2.55 | 2.31 | 3.18 | 2.88 | 4.12 | 3.72 | | | | |
| 6 | 1.57 | 1.45 | 1.85 | 1.71 | 2.20 | 2.03 | 2.66 | 2.46 | 3.31 | 3.05 | 4.26 | 3.94 | | |
| 6¼ | 1.42 | 1.34 | 1.65 | 1.56 | 1.94 | 1.82 | 2.29 | 2.16 | 2.77 | 2.61 | 3.42 | 3.22 | 4.40 | 4.14 |
| 6½ | 1.31 | 1.25 | 1.50 | 1.44 | 1.73 | 1.66 | 2.02 | 1.93 | 2.38 | 2.28 | 2.86 | 2.74 | 3.53 | 3.38 |
| 6¾ | 1.21 | 1.17 | 1.38 | 1.33 | 1.57 | 1.52 | 1.81 | 1.75 | 2.10 | 2.04 | 2.47 | 2.39 | 2.95 | 2.87 |
| 7 | 1.13 | 1.11 | 1.27 | 1.25 | 1.44 | 1.41 | 1.64 | 1.61 | 1.88 | 1.84 | 2.17 | 2.13 | 2.55 | 2.50 |
| 7¼ | 1.06 | 1.05 | 1.19 | 1.17 | 1.33 | 1.32 | 1.50 | 1.49 | 1.70 | 1.69 | 1.94 | 1.92 | 2.24 | 2.22 |
| 7½ | 1.00 | 1.00 | 1.11 | 1.11 | 1.24 | 1.24 | 1.39 | 1.38 | 1.56 | 1.55 | 1.76 | 1.76 | 2.01 | 2.00 |
| 7¾ | 0.95 | 0.95 | 1.05 | 1.05 | 1.17 | 1.17 | 1.30 | 1.30 | 1.45 | 1.44 | 1.62 | 1.62 | 1.82 | 1.82 |
| 8 | 0.91 | 0.91 | 1.00 | 1.00 | 1.10 | 1.10 | 1.22 | 1.22 | 1.35 | 1.35 | 1.50 | 1.50 | 1.67 | 1.67 |
| 8¼ | 0.87 | 0.87 | 0.95 | 0.95 | 1.05 | 1.05 | 1.15 | 1.15 | 1.27 | 1.26 | 1.40 | 1.39 | 1.54 | 1.54 |
| 8½ | 0.84 | 0.83 | 0.91 | 0.91 | 1.00 | 1.00 | 1.09 | 1.09 | 1.20 | 1.19 | 1.31 | 1.30 | 1.44 | 1.43 |
| 8¾ | 0.81 | 0.80 | 0.88 | 0.87 | 0.96 | 0.95 | 1.04 | 1.03 | 1.14 | 1.12 | 1.24 | 1.22 | 1.35 | 1.34 |
| 9 | 0.78 | 0.77 | 0.85 | 0.83 | 0.92 | 0.90 | 1.00 | 0.98 | 1.08 | 1.06 | 1.18 | 1.15 | 1.28 | 1.25 |
| 9¼ | 0.76 | 0.74 | 0.82 | 0.80 | 0.89 | 0.86 | 0.96 | 0.93 | 1.04 | 1.01 | 1.12 | 1.09 | 1.21 | 1.18 |
| 9½ | 0.74 | 0.71 | 0.80 | 0.77 | 0.86 | 0.83 | 0.93 | 0.89 | 1.00 | 0.96 | 1.08 | 1.03 | 1.16 | 1.11 |
| 9¾ | 0.73 | 0.68 | 0.78 | 0.74 | 0.84 | 0.79 | 0.90 | 0.85 | 0.97 | 0.91 | 1.04 | 0.97 | 1.11 | 1.04 |
| 10 | 0.71 | 0.66 | 0.77 | 0.71 | 0.82 | 0.76 | 0.88 | 0.81 | 0.94 | 0.87 | 1.00 | 0.92 | 1.07 | 0.99 |
| 10¼ | 0.70 | 0.63 | 0.75 | 0.68 | 0.80 | 0.72 | 0.86 | 0.77 | 0.91 | 0.82 | 0.97 | 0.88 | 1.03 | 0.93 |
| 10½ | 0.69 | 0.61 | 0.74 | 0.65 | 0.79 | 0.69 | 0.84 | 0.74 | 0.89 | 0.78 | 0.94 | 0.83 | 1.00 | 0.88 |
| 10¾ | 0.68 | 0.59 | 0.73 | 0.63 | 0.77 | 0.66 | 0.82 | 0.70 | 0.87 | 0.75 | 0.92 | 0.79 | 0.97 | 0.83 |
| 11 | 0.68 | 0.56 | 0.72 | 0.60 | 0.76 | 0.64 | 0.81 | 0.67 | 0.85 | 0.71 | 0.90 | 0.75 | 0.95 | 0.79 |
| 11¼ | 0.67 | 0.54 | 0.71 | 0.57 | 0.76 | 0.61 | 0.80 | 0.64 | 0.84 | 0.67 | 0.88 | 0.71 | 0.93 | 0.75 |
| 11½ | 0.67 | 0.52 | 0.71 | 0.55 | 0.75 | 0.58 | 0.79 | 0.61 | 0.83 | 0.64 | 0.87 | 0.67 | 0.91 | 0.70 |
| 11¾ | 0.67 | 0.50 | 0.71 | 0.52 | 0.74 | 0.55 | 0.78 | 0.58 | 0.82 | 0.61 | 0.86 | 0.64 | 0.90 | 0.66 |
| 12 | 0.67 | 0.48 | 0.71 | 0.50 | 0.74 | 0.52 | 0.78 | 0.55 | 0.81 | 0.57 | 0.85 | 0.60 | 0.88 | 0.63 |
| 12¼ | 0.67 | 0.45 | 0.71 | 0.48 | 0.74 | 0.50 | 0.77 | 0.52 | 0.81 | 0.54 | 0.84 | 0.56 | 0.87 | 0.59 |
| 12½ | 0.68 | 0.43 | 0.71 | 0.45 | 0.74 | 0.47 | 0.77 | 0.49 | 0.80 | 0.51 | 0.84 | 0.53 | 0.87 | 0.55 |
| 12¾ | 0.68 | 0.41 | 0.71 | 0.43 | 0.74 | 0.44 | 0.77 | 0.46 | 0.80 | 0.48 | 0.83 | 0.50 | 0.86 | 0.51 |
| 13 | 0.69 | 0.38 | 0.72 | 0.40 | 0.75 | 0.42 | 0.78 | 0.43 | 0.80 | 0.45 | 0.83 | 0.46 | 0.86 | 0.48 |
| 13¼ | 0.70 | 0.36 | 0.73 | 0.37 | 0.76 | 0.39 | 0.78 | 0.40 | 0.81 | 0.41 | 0.83 | 0.43 | 0.86 | 0.44 |
| 13½ | 0.71 | 0.34 | 0.74 | 0.35 | 0.76 | 0.36 | 0.79 | 0.37 | 0.81 | 0.38 | 0.84 | 0.39 | 0.86 | 0.41 |
| 13¾ | 0.73 | 0.31 | 0.75 | 0.32 | 0.77 | 0.33 | 0.80 | 0.34 | 0.82 | 0.35 | 0.84 | 0.36 | 0.86 | 0.37 |
| 14 | 0.74 | 0.28 | 0.77 | 0.29 | 0.79 | 0.30 | 0.81 | 0.31 | 0.83 | 0.32 | 0.85 | 0.32 | 0.87 | 0.33 |

| | 5½ | | 5¾ | | 6 | | 6¼ | | 6½ | | 6¾ | | 7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6½ | 4.52 | 4.33 | | | | | | | | | | | | |
| 6¾ | 3.63 | 3.52 | 4.63 | 4.49 | | | | | | | | | | |
| 7 | 3.04 | 2.98 | 3.72 | 3.65 | 4.74 | 4.64 | | | | | | | | |
| 7¼ | 2.62 | 2.59 | 3.11 | 3.08 | 3.80 | 3.76 | 4.83 | 4.77 | | | | | | |
| 7½ | 2.30 | 2.29 | 2.68 | 2.67 | 3.18 | 3.17 | 3.87 | 3.86 | 4.91 | 4.88 | | | | |
| 7¾ | 2.06 | 2.06 | 2.36 | 2.36 | 2.74 | 2.74 | 3.24 | 3.24 | 3.94 | 3.93 | 4.97 | 4.97 | | |
| 8 | 1.87 | 1.87 | 2.11 | 2.11 | 2.41 | 2.41 | 2.79 | 2.79 | 3.30 | 3.30 | 3.99 | 3.99 | 5.03 | 5.03 |
| 8¼ | 1.72 | 1.71 | 1.92 | 1.92 | 2.16 | 2.16 | 2.46 | 2.46 | 2.84 | 2.84 | 3.34 | 3.34 | 4.04 | 4.03 |
| 8½ | 1.59 | 1.58 | 1.76 | 1.75 | 1.96 | 1.95 | 2.20 | 2.19 | 2.50 | 2.49 | 2.88 | 2.87 | 3.38 | 3.36 |
| 8¾ | 1.48 | 1.46 | 1.63 | 1.61 | 1.80 | 1.78 | 2.00 | 1.98 | 2.24 | 2.21 | 2.53 | 2.51 | 2.91 | 2.88 |
| 9 | 1.39 | 1.36 | 1.52 | 1.49 | 1.66 | 1.63 | 1.83 | 1.80 | 2.03 | 1.99 | 2.27 | 2.23 | 2.56 | 2.51 |
| 9¼ | 1.31 | 1.27 | 1.42 | 1.38 | 1.55 | 1.50 | 1.69 | 1.64 | 1.86 | 1.81 | 2.06 | 2.00 | 2.29 | 2.23 |
| 9½ | 1.25 | 1.19 | 1.35 | 1.29 | 1.46 | 1.39 | 1.58 | 1.51 | 1.72 | 1.65 | 1.89 | 1.81 | 2.08 | 1.99 |
| 9¾ | 1.19 | 1.12 | 1.28 | 1.20 | 1.38 | 1.30 | 1.48 | 1.40 | 1.61 | 1.51 | 1.75 | 1.64 | 1.91 | 1.80 |
| 10 | 1.14 | 1.05 | 1.22 | 1.13 | 1.31 | 1.21 | 1.40 | 1.30 | 1.51 | 1.39 | 1.62 | 1.50 | 1.77 | 1.63 |
| 10¼ | 1.10 | 0.99 | 1.17 | 1.06 | 1.25 | 1.13 | 1.33 | 1.20 | 1.42 | 1.29 | 1.53 | 1.38 | 1.65 | 1.49 |
| 10½ | 1.06 | 0.94 | 1.13 | 0.99 | 1.20 | 1.05 | 1.27 | 1.12 | 1.35 | 1.19 | 1.44 | 1.27 | 1.55 | 1.36 |
| 10¾ | 1.03 | 0.88 | 1.09 | 0.93 | 1.15 | 0.99 | 1.22 | 1.04 | 1.29 | 1.11 | 1.37 | 1.18 | 1.46 | 1.25 |
| 11 | 1.00 | 0.83 | 1.05 | 0.88 | 1.11 | 0.92 | 1.17 | 0.97 | 1.24 | 1.03 | 1.31 | 1.09 | 1.39 | 1.15 |
| 11¼ | 0.98 | 0.78 | 1.03 | 0.82 | 1.08 | 0.87 | 1.13 | 0.91 | 1.19 | 0.96 | 1.25 | 1.01 | 1.32 | 1.06 |
| 11½ | 0.95 | 0.73 | 1.00 | 0.77 | 1.05 | 0.81 | 1.10 | 0.85 | 1.15 | 0.89 | 1.21 | 0.93 | 1.27 | 0.98 |
| 11¾ | 0.94 | 0.69 | 0.98 | 0.72 | 1.02 | 0.76 | 1.07 | 0.79 | 1.12 | 0.83 | 1.17 | 0.86 | 1.22 | 0.90 |
| 12 | 0.92 | 0.65 | 0.96 | 0.68 | 1.00 | 0.71 | 1.04 | 0.73 | 1.09 | 0.77 | 1.13 | 0.80 | 1.18 | 0.83 |
| 12¼ | 0.91 | 0.61 | 0.94 | 0.63 | 0.98 | 0.66 | 1.02 | 0.68 | 1.06 | 0.71 | 1.10 | 0.74 | 1.14 | 0.77 |
| 12½ | 0.90 | 0.57 | 0.93 | 0.59 | 0.97 | 0.61 | 1.00 | 0.63 | 1.04 | 0.66 | 1.07 | 0.68 | 1.11 | 0.71 |
| 12¾ | 0.89 | 0.53 | 0.92 | 0.55 | 0.95 | 0.57 | 0.98 | 0.59 | 1.02 | 0.61 | 1.05 | 0.63 | 1.08 | 0.65 |
| 13 | 0.89 | 0.49 | 0.91 | 0.51 | 0.94 | 0.52 | 0.97 | 0.54 | 1.00 | 0.56 | 1.03 | 0.57 | 1.06 | 0.59 |
| 13¼ | 0.88 | 0.45 | 0.91 | 0.47 | 0.93 | 0.48 | 0.96 | 0.49 | 0.99 | 0.51 | 1.01 | 0.52 | 1.04 | 0.54 |
| 13½ | 0.88 | 0.42 | 0.91 | 0.43 | 0.93 | 0.44 | 0.95 | 0.45 | 0.98 | 0.46 | 1.00 | 0.47 | 1.02 | 0.48 |
| 13¾ | 0.88 | 0.38 | 0.90 | 0.39 | 0.92 | 0.40 | 0.95 | 0.41 | 0.97 | 0.41 | 0.99 | 0.42 | 1.01 | 0.43 |
| 14 | 0.89 | 0.34 | 0.91 | 0.35 | 0.92 | 0.35 | 0.94 | 0.36 | 0.90 | 0.37 | 0.98 | 0.38 | 1.00 | 0.38 |

# TABLE 5A.

### Distance of an Object by Two Bearings.

**Difference between the course and first bearing, in points.**

| Difference between the course and second bearing, in points. | 7¼ | | 7½ | | 7¾ | | 8 | | 8¼ | | 8½ | | 8¾ | | 9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8¼ | 5.07 | 5.06 | | | | | | | | | | | | | | |
| 8½ | 4.07 | 4.05 | 5.10 | 5.08 | | | | | | | | | | | | |
| 8¾ | 3.41 | 3.37 | 4.10 | 4.06 | 5.12 | 5.06 | | | | | | | | | | |
| 9 | 2.94 | 2.88 | 3.43 | 3.36 | 4.11 | 4.03 | 5.13 | 5.03 | | | | | | | | |
| 9¼ | 2.58 | 2.51 | 2.95 | 2.87 | 3.44 | 3.34 | 4.12 | 3.39 | 5.12 | 4.97 | | | | | | |
| 9½ | 2.31 | 2.21 | 2.60 | 2.49 | 2.96 | 2.84 | 3.44 | 3.30 | 4.11 | 3.93 | 5.10 | 4.88 | | | | |
| 9¾ | 2.10 | 1.98 | 2.33 | 2.19 | 2.61 | 2.46 | 2.97 | 2.79 | 3.44 | 3.24 | 4.10 | 3.86 | 5.07 | 4.77 | | |
| 10 | 1.92 | 1.78 | 2.11 | 1.95 | 2.34 | 2.16 | 2.61 | 2.41 | 2.96 | 2.74 | 3.43 | 3.17 | 4.07 | 3.76 | 5.03 | 4.64 |
| 10¼ | 1.78 | 1.61 | 1.93 | 1.75 | 2.12 | 1.92 | 2.34 | 2.11 | 2.61 | 2.36 | 2.95 | 2.67 | 3.41 | 3.08 | 4.04 | 3.65 |
| 10½ | 1.66 | 1.46 | 1.79 | 1.58 | 1.94 | 1.71 | 2.12 | 1.87 | 2.34 | 2.06 | 2.60 | 2.29 | 2.94 | 2.59 | 3.38 | 2.98 |
| 10¾ | 1.56 | 1.34 | 1.67 | 1.43 | 1.80 | 1.54 | 1.95 | 1.67 | 2.12 | 1.82 | 2.33 | 2.00 | 2.58 | 2.22 | 2.91 | 2.50 |
| 11 | 1.47 | 1.22 | 1.57 | 1.30 | 1.68 | 1.39 | 1.80 | 1.50 | 1.94 | 1.62 | 2.11 | 1.76 | 2.31 | 1.92 | 2.56 | 2.13 |
| 11¼ | 1.40 | 1.12 | 1.48 | 1.19 | 1.57 | 1.26 | 1.68 | 1.35 | 1.80 | 1.44 | 1.93 | 1.55 | 2.10 | 1.69 | 2.29 | 1.84 |
| 11½ | 1.34 | 1.03 | 1.41 | 1.09 | 1.49 | 1.15 | 1.58 | 1.22 | 1.68 | 1.30 | 1.79 | 1.38 | 1.92 | 1.49 | 2.08 | 1.61 |
| 11¾ | 1.28 | 0.95 | 1.34 | 1.00 | 1.41 | 1.05 | 1.49 | 1.10 | 1.57 | 1.17 | 1.67 | 1.24 | 1.78 | 1.32 | 1.91 | 1.41 |
| 12 | 1.23 | 0.87 | 1.29 | 0.91 | 1.35 | 0.95 | 1.41 | 1.00 | 1.49 | 1.05 | 1.57 | 1.11 | 1.66 | 1.17 | 1.77 | 1.25 |
| 12¼ | 1.19 | 0.80 | 1.24 | 0.83 | 1.29 | 0.87 | 1.35 | 0.91 | 1.41 | 0.95 | 1.48 | 1.00 | 1.56 | 1.05 | 1.65 | 1.11 |
| 12½ | 1.15 | 0.73 | 1.20 | 0.76 | 1.24 | 0.79 | 1.29 | 0.82 | 1.35 | 0.86 | 1.41 | 0.89 | 1.47 | 0.93 | 1.55 | 0.98 |
| 12¾ | 1.12 | 0.67 | 1.16 | 0.69 | 1.20 | 0.72 | 1.25 | 0.74 | 1.29 | 0.77 | 1.34 | 0.80 | 1.40 | 0.83 | 1.46 | 0.87 |
| 13 | 1.09 | 0.61 | 1.13 | 0.63 | 1.16 | 0.65 | 1.20 | 0.67 | 1.24 | 0.69 | 1.29 | 0.72 | 1.34 | 0.74 | 1.39 | 0.77 |
| 13¼ | 1.07 | 0.55 | 1.10 | 0.57 | 1.13 | 0.58 | 1.17 | 0.60 | 1.20 | 0.62 | 1.24 | 0.64 | 1.28 | 0.66 | 1.32 | 0.68 |
| 13½ | 1.05 | 0.50 | 1.08 | 0.51 | 1.10 | 0.52 | 1.13 | 0.53 | 1.16 | 0.55 | 1.20 | 0.56 | 1.23 | 0.58 | 1.27 | 0.60 |
| 13¾ | 1.03 | 0.44 | 1.06 | 0.45 | 1.08 | 0.46 | 1.11 | 0.47 | 1.13 | 0.48 | 1.16 | 0.50 | 1.19 | 0.51 | 1.22 | 0.52 |
| 14 | 1.02 | 0.39 | 1.04 | 0.40 | 1.06 | 0.41 | 1.08 | 0.41 | 1.10 | 0.42 | 1.13 | 0.43 | 1.15 | 0.44 | 1.18 | 0.45 |

| | 9¼ | | 9½ | | 9¾ | | 10 | | 10¼ | | 10½ | | 10¾ | | 11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10¼ | 4.97 | 4.50 | | | | | | | | | | | | | | |
| 10½ | 3.99 | 3.52 | 4.91 | 4.33 | | | | | | | | | | | | |
| 10¾ | 3.34 | 2.87 | 3.94 | 3.38 | 4.83 | 4.14 | | | | | | | | | | |
| 11 | 2.88 | 2.39 | 3.30 | 2.74 | 3.87 | 3.22 | 4.74 | 3.94 | | | | | | | | |
| 11¼ | 2.53 | 2.04 | 2.84 | 2.28 | 3.24 | 2.61 | 3.80 | 3.05 | 4.63 | 3.72 | | | | | | |
| 11½ | 2.27 | 1.75 | 2.50 | 1.93 | 2.79 | 2.16 | 3.18 | 2.46 | 3.72 | 2.88 | 4.52 | 3.49 | | | | |
| 11¾ | 2.06 | 1.52 | 2.24 | 1.66 | 2.46 | 1.82 | 2.74 | 2.03 | 3.11 | 2.31 | 3.63 | 2.69 | 4.40 | 3.20 | | |
| 12 | 1.89 | 1.33 | 2.03 | 1.44 | 2.20 | 1.56 | 2.41 | 1.71 | 2.68 | 1.90 | 3.04 | 2.15 | 3.53 | 2.50 | 4.26 | 3.01 |
| 12¼ | 1.75 | 1.18 | 1.86 | 1.25 | 2.00 | 1.34 | 2.16 | 1.45 | 2.36 | 1.59 | 2.62 | 1.76 | 2.95 | 1.98 | 3.42 | 2.30 |
| 12½ | 1.62 | 1.03 | 1.72 | 1.09 | 1.83 | 1.16 | 1.96 | 1.24 | 2.11 | 1.34 | 2.30 | 1.46 | 2.55 | 1.62 | 2.86 | 1.82 |
| 12¾ | 1.53 | 0.91 | 1.61 | 0.96 | 1.69 | 1.01 | 1.80 | 1.07 | 1.92 | 1.14 | 2.06 | 1.23 | 2.24 | 1.34 | 2.47 | 1.47 |
| 13 | 1.44 | 0.80 | 1.51 | 0.84 | 1.58 | 0.88 | 1.66 | 0.92 | 1.76 | 0.98 | 1.87 | 1.04 | 2.01 | 1.11 | 2.17 | 1.21 |
| 13¼ | 1.37 | 0.71 | 1.42 | 0.73 | 1.48 | 0.76 | 1.55 | 0.80 | 1.63 | 0.84 | 1.72 | 0.88 | 1.82 | 0.94 | 1.94 | 1.00 |
| 13½ | 1.31 | 0.62 | 1.35 | 0.64 | 1.40 | 0.66 | 1.46 | 0.69 | 1.52 | 0.72 | 1.59 | 0.75 | 1.67 | 0.79 | 1.76 | 0.83 |
| 13¾ | 1.25 | 0.54 | 1.29 | 0.55 | 1.33 | 0.57 | 1.38 | 0.59 | 1.42 | 0.61 | 1.48 | 0.63 | 1.54 | 0.66 | 1.62 | 0.69 |
| 14 | 1.21 | 0.46 | 1.24 | 0.47 | 1.27 | 0.49 | 1.31 | 0.50 | 1.35 | 0.52 | 1.39 | 0.53 | 1.44 | 0.55 | 1.50 | 0.57 |

| | 11¼ | | 11½ | | 11¾ | | 12 | | 12¼ | | 12½ | | 12¾ | | 13 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12¼ | 4.12 | 2.77 | | | | | | | | | | | | | | |
| 12½ | 3.31 | 2.10 | 3.96 | 2.51 | | | | | | | | | | | | |
| 12¾ | 2.77 | 1.65 | 3.18 | 1.90 | 3.80 | 2.26 | | | | | | | | | | |
| 13 | 2.38 | 1.32 | 2.66 | 1.48 | 3.05 | 1.69 | 3.62 | 2.01 | | | | | | | | |
| 13¼ | 2.10 | 1.08 | 2.29 | 1.18 | 2.55 | 1.31 | 2.91 | 1.50 | 3.44 | 1.77 | | | | | | |
| 13½ | 1.88 | 0.89 | 2.02 | 0.95 | 2.20 | 1.04 | 2.44 | 1.15 | 2.76 | 1.30 | 3.25 | 1.53 | | | | |
| 13¾ | 1.70 | 0.73 | 1.81 | 0.77 | 1.94 | 0.83 | 2.10 | 0.90 | 2.31 | 0.99 | 2.61 | 1.12 | 3.05 | 1.31 | | |
| 14 | 1.56 | 0.60 | 1.64 | 0.63 | 1.73 | 0.66 | 1.85 | 0.71 | 1.99 | 0.76 | 2.19 | 0.84 | 2.45 | 0.94 | 2.85 | 1.09 |

## Distance of an Object by Two Bearings.

| Difference between the course and second bearing. | Difference between the course and first bearing. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20° | | 22° | | 24° | | 26° | | 28° | | 30° | | 32° |
| 30° | 1.97 | 0.98 | | | | | | | | | | | |
| 32 | 1.64 | 0.87 | 2.16 | 1.14 | | | | | | | | | |
| 34 | 1.41 | 0.79 | 1.80 | 1.01 | 2.34 | 1.31 | | | | | | | |
| 36 | 1.24 | 0.73 | 1.55 | 0.91 | 1.96 | 1.15 | 2.52 | 1.48 | | | | | |
| 38 | 1.11 | 0.68 | 1.36 | 0.84 | 1.68 | 1.04 | 2.11 | 1.30 | 2.70 | 1.66 | | | |
| 40 | 1.00 | 0.64 | 1.21 | 0.78 | 1.48 | 0.95 | 1.81 | 1.16 | 2.26 | 1.45 | 2.88 | 1.85 | |
| 42 | 0.91 | 0.61 | 1.10 | 0.73 | 1.32 | 0.88 | 1.59 | 1.06 | 1.94 | 1.30 | 2.40 | 1.61 | 3.05 | 2.04 |
| 44 | 0.84 | 0.58 | 1.00 | 0.69 | 1.19 | 0.83 | 1.42 | 0.98 | 1.70 | 1.18 | 2.07 | 1.44 | 2.55 | 1.77 |
| 46 | 0.78 | 0.56 | 0.92 | 0.66 | 1.09 | 0.78 | 1.28 | 0.92 | 1.52 | 1.09 | 1.81 | 1.30 | 2.19 | 1.58 |
| 48 | 0.73 | 0.54 | 0.85 | 0.64 | 1.00 | 0.74 | 1.17 | 0.87 | 1.37 | 1.02 | 1.62 | 1.20 | 1.92 | 1.43 |
| 50 | 0.68 | 0.52 | 0.80 | 0.61 | 0.93 | 0.71 | 1.08 | 0.83 | 1.25 | 0.96 | 1.46 | 1.12 | 1.71 | 1.31 |
| 52 | 0.65 | 0.51 | 0.75 | 0.59 | 0.87 | 0.68 | 1.00 | 0.79 | 1.15 | 0.91 | 1.33 | 1.05 | 1.55 | 1.22 |
| 54 | 0.61 | 0.49 | 0.71 | 0.57 | 0.81 | 0.66 | 0.93 | 0.76 | 1.07 | 0.87 | 1.23 | 0.99 | 1.41 | 1.14 |
| 56 | 0.58 | 0.48 | 0.67 | 0.56 | 0.77 | 0.64 | 0.88 | 0.73 | 1.00 | 0.83 | 1.14 | 0.95 | 1.30 | 1.08 |
| 58 | 0.56 | 0.47 | 0.64 | 0.54 | 0.73 | 0.62 | 0.83 | 0.70 | 0.94 | 0.80 | 1.07 | 0.90 | 1.21 | 1.03 |
| 60 | 0.53 | 0.46 | 0.61 | 0.53 | 0.69 | 0.60 | 0.78 | 0.68 | 0.89 | 0.77 | 1.00 | 0.87 | 1.13 | 0.98 |
| 62 | 0.51 | 0.45 | 0.58 | 0.51 | 0.66 | 0.58 | 0.75 | 0.66 | 0.84 | 0.74 | 0.94 | 0.83 | 1.06 | 0.94 |
| 64 | 0.49 | 0.44 | 0.56 | 0.50 | 0.63 | 0.57 | 0.71 · | 0.64 | 0.80 | 0.72 | 0.89 | 0.80 | 1.00 | 0.90 |
| 66 | 0.48 | 0.43 | 0.54 | 0.49 | 0.61 | 0.56 | 0.68 | 0.62 | 0.76 | 0.70 | 0.85 | 0.78 | 0.95 | 0.87 |
| 68 | 0.46 | 0.43 | 0.52 | 0.48 | 0.59 | 0.54 | 0.66 | 0.61 | 0.73 | 0.68 | 0.81 | 0.75 | 0.90 | 0.84 |
| 70 | 0.45 | 0.42 | 0.50 | 0.47 | 0.57 | 0.53 | 0.63 | 0.59 | 0.70 | 0.66 | 0.78 | 0.73 | 0.86 | 0.81 |
| 72 | 0.43 | 0.41 | 0.49 | 0.47 | 0.55 | 0.52 | 0.61 | 0.58 | 0.68 | 0.64 | 0.75 | 0.71 | 0.82 | 0.78 |
| 74 | 0.42 | 0.41 | 0.48 | 0.46 | 0.53 | 0.51 | 0.59 | 0.57 | 0.65 | 0.63 | 0.72 | 0.69 | 0.79 | 0.76 |
| 76 | 0.41 | 0.40 | 0.46 | 0.45 | 0.52 | 0.50 | 0.57 | 0.56 | 0.63 | 0.61 | 0.70 | 0.67 | 0.76 | 0.74 |
| 78 | 0.40 | 0.39 | 0.45 | 0.44 | 0.50 | 0.49 | 0.56 | 0.54 | 0.61 | 0.60 | 0.67 | 0.66 | 0.74 | 0.72 |
| 80 | 0.39 | 0.39 | 0.44 | 0.44 | 0.49 | 0.48 | 0.54 | 0.53 | 0.60 | 0.59 | 0.65 | 0.64 | 0.71 | 0.70 |
| 82 | 0.39 | 0.38 | 0.43 | 0.43 | 0.48 | 0.47 | 0.53 | 0.52 | 0.58 | 0.57 | 0.63 | 0.63 | 0.69 | 0.69 |
| 84 | 0.38 | 0.38 | 0.42 | 0.42 | 0.47 | 0.47 | 0.52 | 0.51 | 0.57 | 0.56 | 0.62 | 0.61 | 0.67 | 0.67 |
| 86 | 0.37 | 0.37 | 0.42 | 0.42 | 0.46 | 0.46 | 0.51 | 0.51 | 0.55 | 0.55 | 0.60 | 0.60 | 0.66 | 0.65 |
| 88 | 0.37 | 0.37 | 0.41 | 0.41 | 0.45 | 0.45 | 0.50 | 0.50 | 0.54 | 0.54 | 0.59 | 0.59 | 0.64 | 0.64 |
| 90 | 0.36 | 0.36 | 0.40 | 0.40 | 0.45 | 0.45 | 0.49 | 0.49 | 0.53 | 0.53 | 0.58 | 0.58 | 0.62 | 0.62 |
| 92 | 0.36 | 0.36 | 0.40 | 0.40 | 0.44 | 0.44 | 0.48 | 0.48 | 0.52 | 0.52 | 0.57 | 0.57 | 0.61 | 0.61 |
| 94 | 0.36 | 0.35 | 0.39 | 0.39 | 0.43 | 0.43 | 0.47 | 0.47 | 0.51 | 0.51 | 0.56 | 0.55 | 0.60 | 0.60 |
| 96 | 0.35 | 0.35 | 0.39 | 0.39 | 0.43 | 0.43 | 0.47 | 0.46 | 0.51 | 0.50 | 0.55 | 0.54 | 0.59 | 0.59 |
| 98 | 0.35 | 0.35 | 0.39 | 0.38 | 0.42 | 0.42 | 0.46 | 0.46 | 0.50 | 0.50 | 0.54 | 0.53 | 0.58 | 0.57 |
| 100 | 0.35 | 0.34 | 0.38 | 0.38 | 0.42 | 0.41 | 0.46 | 0.45 | 0.49 | 0.49 | 0.53 | 0.52 | 0.57 | 0.56 |
| 102 | 0.35 | 0.34 | 0.38 | 0.37 | 0.42 | 0.41 | 0.45 | 0.44 | 0.49 | 0.48 | 0.53 | 0.51 | 0.56 | 0.55 |
| 104 | 0.34 | 0.33 | 0.38 | 0.37 | 0.41 | 0.40 | 0.45 | 0.43 | 0.48 | 0.47 | 0.52 | 0.50 | 0.56 | 0.54 |
| 106 | 0.34 | 0.33 | 0.38 | 0.36 | 0.41 | 0.39 | 0.45 | 0.43 | 0.48 | 0.46 | 0.52 | 0.50 | 0.55 | 0.53 |
| 108 | 0.34 | 0.32 | 0.38 | 0.36 | 0.41 | 0.39 | 0.44 | 0.42 | 0.48 | 0.45 | 0.51 | 0.49 | 0.55 | 0.52 |
| 110 | 0.34 | 0.32 | 0.37 | 0.35 | 0.41 | 0.38 | 0.44 | 0.41 | 0.47 | 0.44 | 0.51 | 0.48 | 0.54 | 0.51 |
| 112 | 0.34 | 0.32 | 0.37 | 0.35 | 0.41 | 0.38 | 0.44 | 0.41 | 0.47 | 0.44 | 0.50 | 0.47 | 0.54 | 0.50 |
| 114 | 0.34 | 0.31 | 0.37 | 0.34 | 0.41 | 0.37 | 0.44 | 0.40 | 0.47 | 0.43 | 0.50 | 0.46 | 0.54 | 0.49 |
| 116 | 0.34 | 0.31 | 0.38 | 0.34 | 0.41 | 0.37 | 0.44 | 0.39 | 0.47 | 0.42 | 0.50 | 0.45 | 0.53 | 0.48 |
| 118 | 0.35 | 0.31 | 0.38 | 0.33 | 0.41 | 0.36 | 0.44 | 0.39 | 0.47 | 0.41 | 0.50 | 0.44 | 0.53 | 0.47 |
| 120 | 0.35 | 0.30 | 0.38 | 0.33 | 0.41 | 0.36 | 0.44 | 0.38 | 0.47 | 0.41 | 0.50 | 0.43 | 0.53 | 0.46 |
| 122 | 0.35 | 0.30 | 0.38 | 0.32 | 0.41 | 0.35 | 0.44 | 0.37 | 0.47 | 0.40 | 0.50 | 0.42 | 0.53 | 0.45 |
| 124 | 0.35 | 0.29 | 0.38 | 0.32 | 0.41 | 0.34 | 0.44 | 0.37 | 0.47 | 0.39 | 0.50 | 0.42 | 0.53 | 0.44 |
| 126 | 0.36 | 0.29 | 0.39 | 0.31 | 0.42 | 0.34 | 0.45 | 0.36 | 0.47 | 0.38 | 0.50 | 0.41 | 0.53 | 0.43 |
| 128 | 0.36 | 0.28 | 0.39 | 0.31 | 0.42 | 0.33 | 0.45 | 0.35 | 0.48 | 0.38 | 0.50 | 0.40 | 0.53 | 0.42 |
| 130 | 0.36 | 0.28 | 0.39 | 0.30 | 0.42 | 0.32 | 0.45 | 0.35 | 0.48 | 0.37 | 0.51 | 0.39 | 0.54 | 0.41 |
| 132 | 0.37 | 0.27 | 0.40 | 0.30 | 0.43 | 0.32 | 0.46 | 0.34 | 0.48 | 0.36 | 0.51 | 0.38 | 0.54 | 0.40 |
| 134 | 0.37 | 0.27 | 0.40 | 0.29 | 0.43 | 0.31 | 0.46 | 0.33 | 0.49 | 0.35 | 0.52 | 0.37 | 0.54 | 0.39 |
| 136 | 0.38 | 0.26 | 0.41 | 0.28 | 0.44 | 0.30 | 0.47 | 0.32 | 0.49 | 0.34 | 0.52 | 0.36 | 0.55 | 0.38 |
| 138 | 0.39 | 0.26 | 0.42 | 0.28 | 0.45 | 0.30 | 0.47 | 0.32 | 0.50 | 0.33 | 0.53 | 0.35 | 0.55 | 0.37 |
| 140 | 0.39 | 0.25 | 0.42 | 0.27 | 0.45 | 0.29 | 0.48 | 0.31 | 0.51 | 0.33 | 0.53 | 0.34 | 0.56 | 0.36 |
| 142 | 0.40 | 0.25 | 0.43 | 0.27 | 0.46 | 0.28 | 0.49 | 0.30 | 0.51 | 0.32 | 0.54 | 0.33 | 0.56 | 0.35 |
| 144 | 0.41 | 0.24 | 0.44 | 0.26 | 0.47 | 0.28 | 0.50 | 0.29 | 0.52 | 0.31 | 0.55 | 0.32 | 0.57 | 0.34 |
| 146 | 0.42 | 0.24 | 0.45 | 0.25 | 0.48 | 0.27 | 0.51 | 0.28 | 0.53 | 0.30 | 0.56 | 0.31 | 0.58 | 0.32 |
| 148 | 0.43 | 0 23 | 0.46 | 0.25 | 0.49 | 0.26 | 0.52 | 0.27 | 0.54 | 0.29 | 0.57 | 0.30 | 0.59 | 0.31 |
| 150 | 0.45 | 0.22 | 0.48 | 0.24 | 0.50 | 0.25 | 0.53 | 0.26 | 0.55 | 0.28 | 0.58 | 0.29 | 0.60 | 0.30 |
| 152 | 0.46 | 0.22 | 0.49 | 0.23 | 0.52 | 0.24 | 0.54 | 0.25 | 0.57 | 0.27 | 0.59 | 0.28 | 0.61 | 0.29 |
| 154 | 0.48 | 0.21 | 0.50 | 0.22 | 0.53 | 0.23 | 0.56 | 0.24 | 0.58 | 0.25 | 0.60 | 0 26 | 0.62 | 0.27 |
| 156 | 0.49 | 0.20 | 0.52 | 0.21 | 0.55 | 0.22 | 0.57 | 0.23 | 0.60 | 0.24 | 0.62 | 0 25 | 0.64 | 0.26 |
| 158 | 0.51 | 0.19 | 0.54 | 0.20 | 0.57 | 0.21 | 0.59 | 0.22 | 0.61 | 0.23 | 0.63 | 0.24 | 0.66 | 0.25 |
| 160 | 0.53 | 0.18 | 0.56 | 0.19 | 0.59 | 0.20 | 0.61 | 0.21 | 0.63 | 0.22 | 0.65 | 0.22 | 0.67 | 0.23 |

# TABLE 5B.

## Distance of an Object by Two Bearings.

| Difference between the course and second bearing. | 34° | | 36° | | 38° | | 40° | | 42° | | 44° | | 46° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44° | 3.22 | 2.24 | | | | | | | | | | | | |
| 46 | 2.69 | 1.93 | 3.39 | 2.43 | | | | | | | | | | |
| 48 | 2.31 | 1.72 | 2.83 | 2.10 | 3.55 | 2.63 | | | | | | | | |
| 50 | 2.03 | 1.55 | 2.43 | 1.86 | 2.96 | 2.27 | 3.70 | 2.84 | | | | | | |
| 52 | 1.81 | 1.43 | 2.13 | 1.68 | 2.54 | 2.01 | 3.09 | 2.44 | 3.85 | 3.04 | | | | |
| 54 | 1.63 | 1.32 | 1.90 | 1.54 | 2.23 | 1.81 | 2.66 | 2.15 | 3.22 | 2.60 | 4.00 | 3.24 | | |
| 56 | 1.49 | 1.24 | 1.72 | 1.42 | 1.99 | 1.65 | 2.33 | 1.93 | 2.77 | 2.29 | 3.34 | 2.77 | 4.14 | 3.43 |
| 58 | 1.37 | 1.17 | 1.57 | 1.33 | 1.80 | 1.53 | 2.08 | 1.76 | 2.43 | 2.06 | 2.87 | 2.44 | 3.46 | 2.93 |
| 60 | 1.28 | 1.10 | 1.45 | 1.25 | 1.64 | 1.42 | 1.88 | 1.63 | 2.17 | 1.88 | 2.52 | 2.18 | 2.97 | 2.57 |
| 62 | 1.19 | 1.05 | 1.34 | 1.18 | 1.51 | 1.34 | 1.72 | 1.52 | 1.96 | 1.73 | 2.25 | 1.98 | 2.61 | 2.30 |
| 64 | 1.12 | 1.01 | 1.25 | 1.13 | 1.40 | 1.26 | 1.58 | 1.42 | 1.79 | 1.61 | 2.03 | 1.83 | 2.33 | 2.09 |
| 66 | 1.06 | 0.96 | 1.18 | 1.07 | 1.31 | 1.20 | 1.47 | 1.34 | 1.65 | 1.51 | 1.85 | 1.69 | 2.10 | 1.92 |
| 68 | 1.00 | 0.93 | 1.11 | 1.03 | 1.23 | 1.14 | 1.37 | 1.27 | 1.53 | 1.42 | 1.71 | 1.58 | 1.92 | 1.78 |
| 70 | 0.95 | 0.89 | 1.05 | 0.99 | 1.16 | 1.09 | 1.29 | 1.21 | 1.43 | 1.34 | 1.58 | 1.49 | 1.77 | 1.66 |
| 72 | 0.91 | 0.86 | 1.00 | 0.95 | 1.10 | 1.05 | 1.21 | 1.15 | 1.34 | 1.27 | 1.48 | 1.41 | 1.64 | 1.56 |
| 74 | 0.87 | 0.84 | 0.95 | 0.92 | 1.05 | 1.01 | 1.15 | 1.10 | 1.26 | 1.21 | 1.39 | 1.34 | 1.53 | 1.47 |
| 76 | 0.84 | 0.81 | 0.91 | 0.89 | 1.00 | 0.97 | 1.09 | 1.06 | 1.20 | 1.16 | 1.31 | 1.27 | 1.44 | 1.40 |
| 78 | 0.80 | 0.79 | 0.88 | 0.86 | 0.96 | 0.94 | 1.04 | 1.02 | 1.14 | 1.11 | 1.24 | 1.22 | 1.36 | 1.33 |
| 80 | 0.78 | 0.77 | 0.85 | 0.83 | 0.92 | 0.91 | 1.00 | 0.98 | 1.09 | 1.07 | 1.18 | 1.16 | 1.28 | 1.27 |
| 82 | 0.75 | 0.75 | 0.82 | 0.81 | 0.89 | 0.88 | 0.96 | 0.95 | 1.04 | 1.03 | 1.13 | 1.12 | 1.22 | 1.21 |
| 84 | 0.73 | 0.73 | 0.79 | 0.79 | 0.86 | 0.85 | 0.93 | 0.92 | 1.00 | 0.99 | 1.08 | 1.07 | 1.17 | 1.16 |
| 86 | 0.71 | 0.71 | 0.77 | 0.77 | 0.83 | 0.83 | 0.89 | 0.89 | 0.96 | 0.96 | 1.04 | 1.04 | 1.12 | 1.12 |
| 88 | 0.69 | 0.69 | 0.75 | 0.75 | 0.80 | 0.80 | 0.86 | 0.86 | 0.93 | 0.93 | 1.00 | 1.00 | 1.08 | 1.07 |
| 90 | 0.67 | 0.67 | 0.73 | 0.73 | 0.78 | 0.78 | 0.84 | 0.84 | 0.90 | 0.90 | 0.97 | 0.97 | 1.04 | 1.04 |
| 92 | 0.66 | 0.66 | 0.71 | 0.71 | 0.76 | 0.76 | 0.82 | 0.82 | 0.87 | 0.87 | 0.93 | 0.93 | 1.00 | 1.00 |
| 94 | 0.65 | 0.64 | 0.69 | 0.69 | 0.74 | 0.74 | 0.79 | 0.79 | 0.85 | 0.85 | 0.91 | 0.90 | 0.97 | 0.97 |
| 96 | 0.63 | 0.63 | 0.68 | 0.67 | 0.71 | 0.72 | 0.78 | 0.77 | 0.83 | 0.82 | 0.88 | 0.88 | 0.94 | 0.93 |
| 98 | 0.62 | 0.62 | 0.67 | 0.66 | 0.71 | 0.70 | 0.76 | 0.75 | 0.81 | 0.80 | 0.86 | 0.85 | 0.91 | 0.90 |
| 100 | 0.61 | 0.60 | 0.65 | 0.64 | 0.70 | 0.69 | 0.74 | 0.73 | 0.79 | 0.78 | 0.84 | 0.83 | 0.89 | 0.88 |
| 102 | 0.60 | 0.59 | 0.64 | 0.63 | 0.68 | 0.67 | 0.73 | 0.71 | 0.77 | 0.76 | 0.82 | 0.80 | 0.87 | 0.85 |
| 104 | 0.60 | 0.58 | 0.63 | 0.61 | 0.67 | 0.65 | 0.72 | 0.69 | 0.76 | 0.74 | 0.80 | 0.78 | 0.85 | 0.82 |
| 106 | 0.59 | 0.57 | 0.63 | 0.60 | 0.66 | 0.64 | 0.70 | 0.68 | 0.74 | 0.72 | 0.79 | 0.76 | 0.83 | 0.80 |
| 108 | 0.58 | 0.55 | 0.62 | 0.59 | 0.66 | 0.62 | 0.69 | 0.66 | 0.73 | 0.70 | 0.77 | 0.74 | 0.81 | 0.77 |
| 110 | 0.58 | 0.54 | 0.61 | 0.57 | 0.65 | 0.61 | 0.68 | 0.64 | 0.72 | 0.68 | 0.76 | 0.71 | 0.80 | 0.75 |
| 112 | 0.57 | 0.53 | 0.61 | 0.56 | 0.64 | 0.59 | 0.68 | 0.63 | 0.71 | 0.66 | 0.75 | 0.69 | 0.79 | 0.73 |
| 114 | 0.57 | 0.52 | 0.60 | 0.55 | 0.63 | 0.58 | 0.67 | 0.61 | 0.70 | 0.64 | 0.74 | 0.68 | 0.78 | 0.71 |
| 116 | 0.56 | 0.51 | 0.60 | 0.54 | 0.63 | 0.57 | 0.66 | 0.60 | 0.70 | 0.63 | 0.73 | 0.66 | 0.77 | 0.69 |
| 118 | 0.56 | 0.50 | 0.59 | 0.52 | 0.63 | 0.55 | 0.66 | 0.58 | 0.69 | 0.61 | 0.72 | 0.64 | 0.76 | 0.67 |
| 120 | 0.56 | 0.49 | 0.59 | 0.51 | 0.62 | 0.54 | 0.65 | 0.57 | 0.68 | 0.59 | 0.72 | 0.62 | 0.75 | 0.65 |
| 122 | 0.56 | 0.47 | 0.59 | 0.50 | 0.62 | 0.53 | 0.65 | 0.55 | 0.68 | 0.58 | 0.71 | 0.60 | 0.74 | 0.63 |
| 124 | 0.56 | 0.46 | 0.59 | 0.49 | 0.62 | 0.51 | 0.65 | 0.54 | 0.68 | 0.56 | 0.71 | 0.58 | 0.74 | 0.61 |
| 126 | 0.56 | 0.45 | 0.59 | 0.48 | 0.62 | 0.50 | 0.64 | 0.52 | 0.67 | 0.54 | 0.70 | 0.57 | 0.73 | 0.59 |
| 128 | 0.56 | 0.44 | 0.59 | 0.46 | 0.62 | 0.49 | 0.64 | 0.51 | 0.67 | 0.53 | 0.70 | 0.55 | 0.73 | 0.57 |
| 130 | 0.56 | 0.43 | 0.59 | 0.45 | 0.62 | 0.47 | 0.64 | 0.49 | 0.67 | 0.51 | 0.70 | 0.53 | 0.72 | 0.55 |
| 132 | 0.56 | 0.42 | 0.59 | 0.44 | 0.62 | 0.46 | 0.64 | 0.48 | 0.67 | 0.50 | 0.70 | 0.52 | 0.72 | 0.54 |
| 134 | 0.57 | 0.41 | 0.59 | 0.43 | 0.62 | 0.45 | 0.64 | 0.46 | 0.67 | 0.48 | 0.69 | 0.50 | 0.72 | 0.52 |
| 136 | 0.57 | 0.40 | 0.60 | 0.41 | 0.62 | 0.43 | 0.65 | 0.45 | 0.67 | 0.47 | 0.70 | 0.48 | 0.72 | 0.50 |
| 138 | 0.58 | 0.39 | 0.60 | 0.40 | 0.63 | 0.42 | 0.65 | 0.43 | 0.67 | 0.45 | 0.70 | 0.47 | 0.72 | 0.48 |
| 140 | 0.58 | 0.37 | 0.61 | 0.39 | 0.63 | 0.40 | 0.65 | 0.42 | 0.68 | 0.43 | 0.70 | 0.45 | 0.72 | 0.46 |
| 142 | 0.59 | 0.36 | 0.61 | 0.38 | 0.63 | 0.39 | 0.66 | 0.41 | 0.68 | 0.42 | 0.70 | 0.43 | 0.72 | 0.45 |
| 144 | 0.60 | 0.35 | 0.62 | 0.36 | 0.64 | 0.38 | 0.66 | 0.39 | 0.68 | 0.40 | 0.71 | 0.41 | 0.73 | 0.43 |
| 146 | 0.60 | 0.34 | 0.63 | 0.35 | 0.65 | 0.36 | 0.67 | 0.37 | 0.69 | 0.39 | 0.71 | 0.40 | 0.73 | 0.41 |
| 148 | 0.61 | 0.32 | 0.63 | 0.34 | 0.66 | 0.35 | 0.68 | 0.36 | 0.70 | 0.37 | 0.72 | 0.38 | 0.74 | 0.39 |
| 150 | 0.62 | 0.31 | 0.64 | 0.32 | 0.66 | 0.33 | 0.68 | 0.34 | 0.70 | 0.35 | 0.72 | 0.36 | 0.74 | 0.37 |
| 152 | 0.63 | 0.30 | 0.65 | 0.31 | 0.67 | 0.32 | 0.69 | 0.33 | 0.71 | 0.33 | 0.73 | 0.34 | 0.75 | 0.35 |
| 154 | 0.65 | 0.28 | 0.67 | 0.29 | 0.68 | 0.30 | 0.70 | 0.31 | 0.72 | 0.32 | 0.74 | 0.32 | 0.76 | 0.33 |
| 156 | 0.66 | 0.27 | 0.68 | 0.28 | 0.70 | 0.28 | 0.72 | 0.29 | 0.73 | 0.30 | 0.75 | 0.30 | 0.77 | 0.31 |
| 158 | 0.67 | 0.25 | 0.69 | 0.26 | 0.71 | 0.27 | 0.73 | 0.27 | 0.74 | 0.28 | 0.76 | 0.28 | 0.78 | 0.29 |
| 160 | 0.69 | 0.24 | 0.71 | 0.24 | 0.73 | 0.25 | 0.74 | 0.25 | 0.76 | 0.26 | 0.77 | 0.26 | 0.79 | 0.27 |

Difference between the course and first bearing.

# TABLE 5B.

### Distance of an Object by Two Bearings.

| Difference between the course and second bearing. | 48° | | 50° | | 52° | | 54° | | 56° | | 58° | | 60° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58° | 4.28 | 3.63 | | | | | | | | | | | | |
| 60 | 3.57 | 3.10 | 4.41 | 3.82 | | | | | | | | | | |
| 62 | 3.07 | 2.71 | 3.68 | 3.25 | 4.54 | 4.01 | | | | | | | | |
| 64 | 2.70 | 2.42 | 3.17 | 2.85 | 3.79 | 3.41 | 4.66 | 4.19 | | | | | | |
| 66 | 2.40 | 2.20 | 2.78 | 2.54 | 3.26 | 2.98 | 3.89 | 3.55 | 4.77 | 4.36 | | | | |
| 68 | 2.17 | 2.01 | 2.48 | 2.30 | 2.86 | 2.65 | 3.34 | 3.10 | 3.99 | 3.71 | 4.88 | 4.53 | | |
| 70 | 1.98 | 1.86 | 2.24 | 2.10 | 2.55 | 2.39 | 2.94 | 2.76 | 3.43 | 3.22 | 4.08 | 3.83 | 4.99 | 4.69 |
| 72 | 1.83 | 1.74 | 2.04 | 1.94 | 2.30 | 2.19 | 2.62 | 2.49 | 3.01 | 2.86 | 3.51 | 3.33 | 4.17 | 3.96 |
| 74 | 1.70 | 1.63 | 1.88 | 1.81 | 2.10 | 2.02 | 2.37 | 2.27 | 2.68 | 2.58 | 3.08 | 2.96 | 3.58 | 3.44 |
| 76 | 1.58 | 1.54 | 1.75 | 1.70 | 1.94 | 1.88 | 2.16 | 2.10 | 2.42 | 2.35 | 2.74 | 2.66 | 3.14 | 3.05 |
| 78 | 1.49 | 1.45 | 1.63 | 1.60 | 1.80 | 1.76 | 1.99 | 1.95 | 2.21 | 2.16 | 2.48 | 2.43 | 2.80 | 2.74 |
| 80 | 1.40 | 1.38 | 1.53 | 1.51 | 1.68 | 1.65 | 1.85 | 1.82 | 2.04 | 2.01 | 2.26 | 2.23 | 2.53 | 2.49 |
| 82 | 1.33 | 1.32 | 1.45 | 1.43 | 1.58 | 1.56 | 1.72 | 1.71 | 1.89 | 1.87 | 2.08 | 2.06 | 2.31 | 2.29 |
| 84 | 1.26 | 1.26 | 1.37 | 1.36 | 1.49 | 1.48 | 1.62 | 1.61 | 1.77 | 1.76 | 1.93 | 1.92 | 2.13 | 2.12 |
| 86 | 1.21 | 1.20 | 1.30 | 1.30 | 1.41 | 1.41 | 1.53 | 1.52 | 1.66 | 1.65 | 1.81 | 1.80 | 1.98 | 1.97 |
| 88 | 1.16 | 1.16 | 1.24 | 1.24 | 1.34 | 1.34 | 1.45 | 1.45 | 1.56 | 1.56 | 1.70 | 1.70 | 1.84 | 1.84 |
| 90 | 1.11 | 1.11 | 1.19 | 1.19 | 1.28 | 1.28 | 1.38 | 1.38 | 1.48 | 1.48 | 1.60 | 1.60 | 1.73 | 1.73 |
| 92 | 1.07 | 1.07 | 1.14 | 1.14 | 1.23 | 1.23 | 1.31 | 1.31 | 1.41 | 1.41 | 1.52 | 1.52 | 1.63 | 1.63 |
| 94 | 1.03 | 1.03 | 1.10 | 1.10 | 1.18 | 1.17 | 1.26 | 1.26 | 1.35 | 1.34 | 1.44 | 1.44 | 1.55 | 1.54 |
| 96 | 1.00 | 0.99 | 1.06 | 1.06 | 1.13 | 1.13 | 1.21 | 1.20 | 1.29 | 1.28 | 1.38 | 1.37 | 1.47 | 1.47 |
| 98 | 0.97 | 0.96 | 1.03 | 1.02 | 1.10 | 1.08 | 1.16 | 1.15 | 1.24 | 1.23 | 1.32 | 1.31 | 1.41 | 1.39 |
| 100 | 0.94 | 0.93 | 1.00 | 0.98 | 1.06 | 1.04 | 1.12 | 1.11 | 1.19 | 1.18 | 1.27 | 1.25 | 1.35 | 1.33 |
| 102 | 0.92 | 0.90 | 0.97 | 0.95 | 1.03 | 1.01 | 1.09 | 1.06 | 1.15 | 1.13 | 1.22 | 1.19 | 1.29 | 1.27 |
| 104 | 0.90 | 0.87 | 0.95 | 0.92 | 1.00 | 0.97 | 1.06 | 1.02 | 1.12 | 1.08 | 1.18 | 1.14 | 1.25 | 1.21 |
| 106 | 0.88 | 0.84 | 0.92 | 0.89 | 0.97 | 0.94 | 1.03 | 0.99 | 1.09 | 1.04 | 1.14 | 1.10 | 1.20 | 1.16 |
| 108 | 0.86 | 0.82 | 0.90 | 0.86 | 0.95 | 0.90 | 1.00 | 0.95 | 1.05 | 1.00 | 1.11 | 1.05 | 1.17 | 1.11 |
| 110 | 0.84 | 0.79 | 0.88 | 0.83 | 0.93 | 0.87 | 0.98 | 0.92 | 1.02 | 0.96 | 1.08 | 1.01 | 1.13 | 1.06 |
| 112 | 0.83 | 0.77 | 0.87 | 0.80 | 0.91 | 0.84 | 0.95 | 0.88 | 1.00 | 0.93 | 1.05 | 0.97 | 1.10 | 1.02 |
| 114 | 0.81 | 0.74 | 0.85 | 0.78 | 0.89 | 0.82 | 0.93 | 0.85 | 0.98 | 0.89 | 1.02 | 0.93 | 1.07 | 0.98 |
| 116 | 0.80 | 0.72 | 0.84 | 0.75 | 0.88 | 0.79 | 0.92 | 0.82 | 0.96 | 0.85 | 1.00 | 0.90 | 1.04 | 0.94 |
| 118 | 0.79 | 0.70 | 0.83 | 0.73 | 0.86 | 0.76 | 0.90 | 0.79 | 0.94 | 0.83 | 0.98 | 0.86 | 1.02 | 0.90 |
| 120 | 0.78 | 0.68 | 0.82 | 0.71 | 0.85 | 0.74 | 0.89 | 0.77 | 0.91 | 0.80 | 0.96 | 0.83 | 1.00 | 0.87 |
| 122 | 0.77 | 0.66 | 0.81 | 0.68 | 0.84 | 0.71 | 0.87 | 0.74 | 0.90 | 0.77 | 0.95 | 0.80 | 0.98 | 0.83 |
| 124 | 0.77 | 0.63 | 0.80 | 0.66 | 0.83 | 0.69 | 0.86 | 0.71 | 0.90 | 0.74 | 0.93 | 0.77 | 0.96 | 0.80 |
| 126 | 0.76 | 0.61 | 0.79 | 0.64 | 0.82 | 0.66 | 0.85 | 0.69 | 0.88 | 0.71 | 0.91 | 0.74 | 0.95 | 0.77 |
| 128 | 0.75 | 0.59 | 0.78 | 0.62 | 0.81 | 0.64 | 0.84 | 0.66 | 0.87 | 0.69 | 0.90 | 0.71 | 0.93 | 0.74 |
| 130 | 0.75 | 0.57 | 0.78 | 0.60 | 0.81 | 0.62 | 0.83 | 0.64 | 0.86 | 0.66 | 0.89 | 0.68 | 0.92 | 0.71 |
| 132 | 0.75 | 0.56 | 0.77 | 0.57 | 0.80 | 0.59 | 0.83 | 0.61 | 0.85 | 0.64 | 0.88 | 0.66 | 0.91 | 0.68 |
| 134 | 0.74 | 0.54 | 0.77 | 0.55 | 0.80 | 0.57 | 0.82 | 0.59 | 0.85 | 0.61 | 0.87 | 0.63 | 0.90 | 0.65 |
| 136 | 0.74 | 0.52 | 0.77 | 0.53 | 0.80 | 0.55 | 0.82 | 0.57 | 0.84 | 0.58 | 0.87 | 0.60 | 0.89 | 0.62 |
| 138 | 0.74 | 0.50 | 0.77 | 0.51 | 0.79 | 0.53 | 0.81 | 0.54 | 0.84 | 0.56 | 0.86 | 0.58 | 0.89 | 0.59 |
| 140 | 0.74 | 0.48 | 0.77 | 0.49 | 0.79 | 0.51 | 0.81 | 0.52 | 0.83 | 0.54 | 0.86 | 0.55 | 0.88 | 0.57 |
| 142 | 0.74 | 0.46 | 0.77 | 0.47 | 0.79 | 0.49 | 0.81 | 0.50 | 0.83 | 0.51 | 0.85 | 0.52 | 0.87 | 0.54 |
| 144 | 0.75 | 0.44 | 0.77 | 0.45 | 0.79 | 0.46 | 0.81 | 0.48 | 0.83 | 0.49 | 0.85 | 0.50 | 0.87 | 0.51 |
| 146 | 0.75 | 0.42 | 0.77 | 0.43 | 0.79 | 0.44 | 0.81 | 0.45 | 0.83 | 0.46 | 0.85 | 0.47 | 0.87 | 0.49 |
| 148 | 0.76 | 0.40 | 0.77 | 0.41 | 0.79 | 0.42 | 0.81 | 0.43 | 0.83 | 0.44 | 0.85 | 0.45 | 0.87 | 0.46 |
| 150 | 0.76 | 0.38 | 0.78 | 0.39 | 0.80 | 0.40 | 0.81 | 0.41 | 0.83 | 0.42 | 0.85 | 0.42 | 0.87 | 0.43 |
| 152 | 0.77 | 0.36 | 0.78 | 0.37 | 0.80 | 0.38 | 0.82 | 0.38 | 0.83 | 0.39 | 0.85 | 0.40 | 0.87 | 0.41 |
| 154 | 0.77 | 0.34 | 0.79 | 0.35 | 0.81 | 0.35 | 0.82 | 0.36 | 0.84 | 0.37 | 0.85 | 0.37 | 0.87 | 0.38 |
| 156 | 0.78 | 0.32 | 0.80 | 0.32 | 0.81 | 0.33 | 0.83 | 0.34 | 0.84 | 0.34 | 0.86 | 0.35 | 0.87 | 0.35 |
| 158 | 0.79 | 0.30 | 0.81 | 0.30 | 0.82 | 0.31 | 0.83 | 0.31 | 0.85 | 0.32 | 0.86 | 0.32 | 0.87 | 0.33 |
| 160 | 0.80 | 0.27 | 0.82 | 0.28 | 0.83 | 0.28 | 0.84 | 0.29 | 0.85 | 0.29 | 0.86 | 0.30 | 0.88 | 0.30 |

Difference between the course and first bearing.

# TABLE 5B.

### Distance of an Object by Two Bearings.

| Difference between the course and second bearing. | Difference between the course and first bearing. | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 62° | | 64° | | 66° | | 68° | | 70° | | 72° | | 74° | | 76° | |
| 72° | 5.08 | 4.84 | | | | | | | | | | | | | | |
| 74 | 4.25 | 4.08 | 5.18 | 4.98 | | | | | | | | | | | | |
| 76 | 3.65 | 3.54 | 4.32 | 4.19 | 5.26 | 5.10 | | | | | | | | | | |
| 78 | 3.20 | 3.13 | 3.72 | 3.63 | 4.39 | 4.30 | 5.34 | 5.22 | | | | | | | | |
| 80 | 2.86 | 2.81 | 3.26 | 3.21 | 3.78 | 3.72 | 4.46 | 4.39 | 5.41 | 5.33 | | | | | | |
| 82 | 2.58 | 2.56 | 2.91 | 2.88 | 3.31 | 3.28 | 3.83 | 3.80 | 4.52 | 4.48 | 5.48 | 5.42 | | | | |
| 84 | 2.36 | 2.34 | 2.63 | 2.61 | 2.96 | 2.94 | 3.36 | 3.35 | 3.88 | 3.86 | 4.57 | 4.55 | 5.54 | 5.51 | | |
| 86 | 2.17 | 2.17 | 2.40 | 2.39 | 2.67 | 2.66 | 3.00 | 2.99 | 3.41 | 3.40 | 3.93 | 3.92 | 4.62 | 4.61 | 5.59 | 5.57 |
| 88 | 2.01 | 2.01 | 2.21 | 2.21 | 2.44 | 2.44 | 2.71 | 2.71 | 3.04 | 3.04 | 3.45 | 3.45 | 3.97 | 3.97 | 4.67 | 4.66 |
| 90 | 1.88 | 1.88 | 2.05 | 2.05 | 2.25 | 2.25 | 2.48 | 2.48 | 2.75 | 2.75 | 3.08 | 3.08 | 3.49 | 3.49 | 4.01 | 4.01 |
| 92 | 1.77 | 1.76 | 1.91 | 1.91 | 2.08 | 2.08 | 2.28 | 2.28 | 2.51 | 2.51 | 2.78 | 2.78 | 3.11 | 3.11 | 3.52 | 3.52 |
| 94 | 1.67 | 1.66 | 1.80 | 1.79 | 1.95 | 1.94 | 2.12 | 2.11 | 2.31 | 2.30 | 2.54 | 2.53 | 2.81 | 2.80 | 3.14 | 3.13 |
| 96 | 1.58 | 1.57 | 1.70 | 1.69 | 1.83 | 1.82 | 1.97 | 1.96 | 2.14 | 2.13 | 2.34 | 2.33 | 2.57 | 2.55 | 2.84 | 2.82 |
| 98 | 1.50 | 1.49 | 1.61 | 1.59 | 1.72 | 1.71 | 1.85 | 1.84 | 2.00 | 1.98 | 2.17 | 2.15 | 2.36 | 2.34 | 2.59 | 2.56 |
| 100 | 1.43 | 1.41 | 1.53 | 1.51 | 1.63 | 1.61 | 1.75 | 1.72 | 1.88 | 1.85 | 2.03 | 2.00 | 2.19 | 2.16 | 2.39 | 2.35 |
| 102 | 1.37 | 1.34 | 1.46 | 1.43 | 1.55 | 1.52 | 1.66 | 1.62 | 1.77 | 1.73 | 1.90 | 1.86 | 2.05 | 2.00 | 2.21 | 2.16 |
| 104 | 1.32 | 1.28 | 1.40 | 1.36 | 1.48 | 1.44 | 1.58 | 1.53 | 1.68 | 1.63 | 1.79 | 1.74 | 1.92 | 1.87 | 2.07 | 2.01 |
| 106 | 1.27 | 1.22 | 1.34 | 1.29 | 1.42 | 1.37 | 1.51 | 1.45 | 1.60 | 1.54 | 1.70 | 1.63 | 1.81 | 1.74 | 1.94 | 1.87 |
| 108 | 1.23 | 1.17 | 1.29 | 1.23 | 1.37 | 1.30 | 1.44 | 1.37 | 1.53 | 1.45 | 1.62 | 1.54 | 1.72 | 1.63 | 1.83 | 1.74 |
| 110 | 1.19 | 1.12 | 1.25 | 1.17 | 1.32 | 1.24 | 1.39 | 1.30 | 1.46 | 1.37 | 1.54 | 1.45 | 1.64 | 1.54 | 1.74 | 1.63 |
| 112 | 1.15 | 1.07 | 1.21 | 1.12 | 1.27 | 1.18 | 1.33 | 1.24 | 1.40 | 1.30 | 1.48 | 1.37 | 1.56 | 1.45 | 1.65 | 1.53 |
| 114 | 1.12 | 1.02 | 1.17 | 1.07 | 1.23 | 1.12 | 1.29 | 1.18 | 1.35 | 1.24 | 1.42 | 1.30 | 1.50 | 1.37 | 1.58 | 1.44 |
| 116 | 1.09 | 0.98 | 1.14 | 1.03 | 1.19 | 1.07 | 1.25 | 1.12 | 1.31 | 1.17 | 1.37 | 1.23 | 1.44 | 1.29 | 1.51 | 1.36 |
| 118 | 1.07 | 0.94 | 1.11 | 0.98 | 1.16 | 1.02 | 1.21 | 1.07 | 1.26 | 1.12 | 1.32 | 1.17 | 1.38 | 1.22 | 1.45 | 1.28 |
| 120 | 1.04 | 0.90 | 1.08 | 0.94 | 1.13 | 0.98 | 1.18 | 1.02 | 1.23 | 1.06 | 1.28 | 1.11 | 1.34 | 1.16 | 1.40 | 1.21 |
| 122 | 1.02 | 0.86 | 1.06 | 0.90 | 1.10 | 0.93 | 1.15 | 0.97 | 1.19 | 1.01 | 1.24 | 1.05 | 1.29 | 1.10 | 1.35 | 1.14 |
| 124 | 1.00 | 0.83 | 1.04 | 0.86 | 1.08 | 0.89 | 1.12 | 0.93 | 1.16 | 0.96 | 1.21 | 1.00 | 1.25 | 1.04 | 1.31 | 1.08 |
| 126 | 0.98 | 0.79 | 1.02 | 0.82 | 1.05 | 0.85 | 1.09 | 0.88 | 1.13 | 0.92 | 1.18 | 0.95 | 1.22 | 0.99 | 1.27 | 1.02 |
| 128 | 0.97 | 0.76 | 1.00 | 0.79 | 1.03 | 0.82 | 1.07 | 0.84 | 1.11 | 0.87 | 1.15 | 0.90 | 1.19 | 0.94 | 1.23 | 0.97 |
| 130 | 0.95 | 0.73 | 0.98 | 0.75 | 1.02 | 0.78 | 1.05 | 0.80 | 1.09 | 0.83 | 1.12 | 0.86 | 1.16 | 0.89 | 1.20 | 0.92 |
| 132 | 0.94 | 0.70 | 0.97 | 0.72 | 1.00 | 0.74 | 1.03 | 0.77 | 1.06 | 0.79 | 1.10 | 0.82 | 1.13 | 0.84 | 1.17 | 0.87 |
| 134 | 0.93 | 0.67 | 0.96 | 0.69 | 0.99 | 0.71 | 1.01 | 0.73 | 1.04 | 0.75 | 1.08 | 0.77 | 1.11 | 0.80 | 1.14 | 0.82 |
| 136 | 0.92 | 0.64 | 0.95 | 0.66 | 0.97 | 0.68 | 1.00 | 0.69 | 1.03 | 0.71 | 1.06 | 0.74 | 1.09 | 0.76 | 1.12 | 0.78 |
| 138 | 0.91 | 0.61 | 0.94 | 0.63 | 0.96 | 0.64 | 0.99 | 0.66 | 1.01 | 0.68 | 1.04 | 0.70 | 1.07 | 0.72 | 1.10 | 0.74 |
| 140 | 0.90 | 0.58 | 0.93 | 0.60 | 0.95 | 0.61 | 0.97 | 0.63 | 1.00 | 0.64 | 1.03 | 0.66 | 1.05 | 0.68 | 1.08 | 0.70 |
| 142 | 0.90 | 0.55 | 0.92 | 0.57 | 0.94 | 0.58 | 0.96 | 0.59 | 0.99 | 0.61 | 1.01 | 0.62 | 1.04 | 0.64 | 1.06 | 0.65 |
| 144 | 0.89 | 0.52 | 0.91 | 0.54 | 0.93 | 0.55 | 0.96 | 0.56 | 0.98 | 0.57 | 1.00 | 0.59 | 1.02 | 0.60 | 1.05 | 0.62 |
| 146 | 0.89 | 0.50 | 0.91 | 0.51 | 0.93 | 0.52 | 0.95 | 0.53 | 0.97 | 0.54 | 0.99 | 0.55 | 1.01 | 0.57 | 1.03 | 0.58 |
| 148 | 0.89 | 0.47 | 0.90 | 0.48 | 0.92 | 0.49 | 0.94 | 0.50 | 0.96 | 0.51 | 0.98 | 0.52 | 1.00 | 0.53 | 1.02 | 0.54 |
| 150 | 0.88 | 0.44 | 0.90 | 0.45 | 0.92 | 0.46 | 0.94 | 0.47 | 0.95 | 0.48 | 0.97 | 0.49 | 0.99 | 0.50 | 1.01 | 0.50 |
| 152 | 0.88 | 0.41 | 0.90 | 0.42 | 0.92 | 0.43 | 0.93 | 0.44 | 0.95 | 0.45 | 0.97 | 0.45 | 0.98 | 0.46 | 1.00 | 0.47 |
| 154 | 0.88 | 0.39 | 0.90 | 0.39 | 0.91 | 0.40 | 0.93 | 0.41 | 0.94 | 0.41 | 0.96 | 0.42 | 0.98 | 0.43 | 0.99 | 0.43 |
| 156 | 0.89 | 0.36 | 0.90 | 0.37 | 0.91 | 0.37 | 0.93 | 0.38 | 0.94 | 0.38 | 0.96 | 0.39 | 0.97 | 0.39 | 0.99 | 0.40 |
| 158 | 0.89 | 0.33 | 0.90 | 0.34 | 0.91 | 0.34 | 0.93 | 0.35 | 0.94 | 0.35 | 0.95 | 0.36 | 0.97 | 0.36 | 0.98 | 0.37 |
| 160 | 0.89 | 0.30 | 0.90 | 0.31 | 0.91 | 0.31 | 0.93 | 0.32 | 0.94 | 0.32 | 0.95 | 0.33 | 0.96 | 0.33 | 0.98 | 0.33 |

### Distance of an Object by Two Bearings.

Difference between the course and first bearing.

| Difference between the course and second bearing. | 78° | | 80° | | 82° | | 84° | | 86° | | 88° | | 90° | | 92° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88° | 5.63 | 5.63 | | | | | | | | | | | | | | |
| 90 | 4.70 | 4.70 | 5.67 | 5.67 | | | | | | | | | | | | |
| 92 | 4.04 | 4.04 | 4.74 | 4.73 | 5.70 | 5.70 | | | | | | | | | | |
| 94 | 3.55 | 3.54 | 4.07 | 4.06 | 4.76 | 4.75 | 5.73 | 5.71 | | | | | | | | |
| 96 | 3.17 | 3.15 | 3.57 | 3.55 | 4.09 | 4.07 | 4.78 | 4.76 | 5.74 | 5.71 | | | | | | |
| 98 | 2.86 | 2.83 | 3.19 | 3.16 | 3.59 | 3.56 | 4.11 | 4.07 | 4.80 | 4.75 | 5.76 | 5.70 | | | | |
| 100 | 2.61 | 2.57 | 2.88 | 2.84 | 3.20 | 3.16 | 3.61 | 3.55 | 4.12 | 4.06 | 4.81 | 4.73 | 5.76 | 5.67 | | |
| 102 | 2.40 | 2.35 | 2.63 | 2.57 | 2.90 | 2.83 | 3.22 | 3.15 | 3.62 | 3.54 | 4.13 | 4.04 | 4.81 | 4.70 | 5.76 | 5.63 |
| 104 | 2.23 | 2.16 | 2.42 | 2.35 | 2.64 | 2.56 | 2.91 | 2.82 | 3.23 | 3.13 | 3.63 | 3.52 | 4.13 | 4.01 | 4.81 | 4.66 |
| 106 | 2.08 | 2.00 | 2.25 | 2.16 | 2.43 | 2.34 | 2.65 | 2.55 | 2.92 | 2.80 | 3.23 | 3.11 | 3.63 | 3.49 | 4.13 | 3.97 |
| 108 | 1.96 | 1.86 | 2.10 | 2.00 | 2.26 | 2.15 | 2.45 | 2.33 | 2.66 | 2.53 | 2.92 | 2.78 | 3.24 | 3.08 | 3.63 | 3.45 |
| 110 | 1.85 | 1.73 | 1.97 | 1.85 | 2.11 | 1.98 | 2.27 | 2.13 | 2.45 | 2.31 | 2.67 | 2.51 | 2.92 | 2.75 | 3.23 | 3.04 |
| 112 | 1.75 | 1.62 | 1.86 | 1.72 | 1.98 | 1.83 | 2.12 | 1.96 | 2.28 | 2.11 | 2.46 | 2.28 | 2.67 | 2.48 | 2.92 | 2.71 |
| 114 | 1.66 | 1.52 | 1.76 | 1.61 | 1.87 | 1.71 | 1.99 | 1.82 | 2.12 | 1.94 | 2.28 | 2.08 | 2.46 | 2.25 | 2.67 | 2.44 |
| 116 | 1.59 | 1.43 | 1.68 | 1.51 | 1.77 | 1.59 | 1.88 | 1.69 | 2.00 | 1.79 | 2.13 | 1.91 | 2.28 | 2.05 | 2.46 | 2.21 |
| 118 | 1.52 | 1.34 | 1.60 | 1.41 | 1.68 | 1.49 | 1.78 | 1.57 | 1.88 | 1.66 | 2.00 | 1.76 | 2.13 | 1.88 | 2.28 | 2.01 |
| 120 | 1.46 | 1.27 | 1.53 | 1.33 | 1.61 | 1.39 | 1.69 | 1.47 | 1.78 | 1.54 | 1.89 | 1.63 | 2.00 | 1.73 | 2.13 | 1.84 |
| 122 | 1.41 | 1.19 | 1.47 | 1.25 | 1.54 | 1.31 | 1.62 | 1.37 | 1.70 | 1.44 | 1.79 | 1.52 | 1.89 | 1.60 | 2.00 | 1.70 |
| 124 | 1.36 | 1.13 | 1.42 | 1.18 | 1.48 | 1.23 | 1.55 | 1.28 | 1.62 | 1.34 | 1.70 | 1.41 | 1.79 | 1.48 | 1.89 | 1.56 |
| 126 | 1.32 | 1.06 | 1.37 | 1.11 | 1.43 | 1.15 | 1.48 | 1.20 | 1.55 | 1.26 | 1.62 | 1.31 | 1.70 | 1.38 | 1.79 | 1.45 |
| 128 | 1.28 | 1.01 | 1.33 | 1.04 | 1.38 | 1.08 | 1.43 | 1.13 | 1.49 | 1.17 | 1.55 | 1.23 | 1.62 | 1.28 | 1.70 | 1.34 |
| 130 | 1.24 | 0.95 | 1.29 | 0.98 | 1.33 | 1.02 | 1.38 | 1.06 | 1.44 | 1.10 | 1.49 | 1.14 | 1.56 | 1.19 | 1.62 | 1.24 |
| 132 | 1.21 | 0.90 | 1.25 | 0.93 | 1.29 | 0.96 | 1.34 | 0.99 | 1.39 | 1.03 | 1.44 | 1.07 | 1.49 | 1.11 | 1.55 | 1.16 |
| 134 | 1.18 | 0.85 | 1.22 | 0.88 | 1.26 | 0.90 | 1.30 | 0.93 | 1.34 | 0.97 | 1.39 | 1.00 | 1.44 | 1.04 | 1.49 | 1.07 |
| 136 | 1.15 | 0.80 | 1.19 | 0.83 | 1.22 | 0.85 | 1.26 | 0.88 | 1.30 | 0.90 | 1.34 | 0.93 | 1.39 | 0.97 | 1.44 | 1.00 |
| 138 | 1.13 | 0.76 | 1.16 | 0.78 | 1.19 | 0.80 | 1.23 | 0.82 | 1.27 | 0.85 | 1.30 | 0.87 | 1.35 | 0.90 | 1.39 | 0.93 |
| 140 | 1.11 | 0.71 | 1.14 | 0.73 | 1.17 | 0.75 | 1.20 | 0.77 | 1.23 | 0.79 | 1.27 | 0.82 | 1.31 | 0.84 | 1.34 | 0.86 |
| 142 | 1.09 | 0.67 | 1.12 | 0.69 | 1.14 | 0.70 | 1.17 | 0.72 | 1.20 | 0.74 | 1.24 | 0.76 | 1.27 | 0.78 | 1.30 | 0.80 |
| 144 | 1.07 | 0.63 | 1.10 | 0.64 | 1.12 | 0.66 | 1.15 | 0.67 | 1.18 | 0.69 | 1.21 | 0.71 | 1.24 | 0.73 | 1.27 | 0.75 |
| 146 | 1.05 | 0.59 | 1.08 | 0.60 | 1.10 | 0.62 | 1.13 | 0.63 | 1.15 | 0.64 | 1.18 | 0.66 | 1.21 | 0.67 | 1.24 | 0.69 |
| 148 | 1.04 | 0.55 | 1.06 | 0.56 | 1.08 | 0.57 | 1.11 | 0.59 | 1.13 | 0.60 | 1.15 | 0.61 | 1.18 | 0.62 | 1.21 | 0.64 |
| 150 | 1.03 | 0.51 | 1.05 | 0.52 | 1.07 | 0.53 | 1.09 | 0.54 | 1.11 | 0.55 | 1.13 | 0.57 | 1.15 | 0.58 | 1.18 | 0.59 |
| 152 | 1.02 | 0.48 | 1.04 | 0.49 | 1.05 | 0.49 | 1.07 | 0.50 | 1.09 | 0.51 | 1.11 | 0.52 | 1.13 | 0.53 | 1.15 | 0.54 |
| 154 | 1.01 | 0.44 | 1.02 | 0.45 | 1.04 | 0.46 | 1.06 | 0.46 | 1.08 | 0.47 | 1.09 | 0.48 | 1.11 | 0.49 | 1.13 | 0.50 |
| 156 | 1.00 | 0.41 | 1.01 | 0.41 | 1.03 | 0.42 | 1.05 | 0.43 | 1.06 | 0.43 | 1.08 | 0.44 | 1.09 | 0.45 | 1.11 | 0.45 |
| 158 | 0.99 | 0.37 | 1.01 | 0.38 | 1.02 | 0.38 | 1.03 | 0.39 | 1.05 | 0.39 | 1.06 | 0.40 | 1.08 | 0.40 | 1.09 | 0.41 |
| 160 | 0.99 | 0.34 | 1.00 | 0.34 | 1.01 | 0.35 | 1.02 | 0.35 | 1.04 | 0.35 | 1.05 | 0.36 | 1.06 | 0.36 | 1.08 | 0.37 |

| Difference between the course and second bearing. | 94° | | 96° | | 98° | | 100° | | 102° | | 104° | | 106° | | 108° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 104° | 5.74 | 5.57 | | | | | | | | | | | | | | |
| 106 | 4.80 | 4.61 | 5.78 | 5.51 | | | | | | | | | | | | |
| 108 | 4.12 | 3.92 | 4.78 | 4.55 | 5.70 | 5.42 | | | | | | | | | | |
| 110 | 3.62 | 3.40 | 4.11 | 3.86 | 4.76 | 4.48 | 5.67 | 5.33 | | | | | | | | |
| 112 | 3.23 | 2.99 | 3.61 | 3.35 | 4.09 | 3.80 | 4.74 | 4.40 | 5.63 | 5.22 | | | | | | |
| 114 | 2.92 | 2.66 | 3.22 | 2.94 | 3.59 | 3.28 | 4.07 | 3.72 | 4.70 | 4.30 | 5.59 | 5.10 | | | | |
| 116 | 2.66 | 2.39 | 2.91 | 2.61 | 3.20 | 2.88 | 3.57 | 3.21 | 4.04 | 3.63 | 4.67 | 4.19 | 5.54 | 4.98 | | |
| 118 | 2.45 | 2.17 | 2.65 | 2.34 | 2.90 | 2.56 | 3.19 | 2.81 | 3.55 | 3.13 | 4.01 | 3.54 | 4.62 | 4.08 | 5.48 | 4.84 |
| 120 | 2.28 | 1.97 | 2.45 | 2.12 | 2.64 | 2.29 | 2.88 | 2.49 | 3.17 | 2.74 | 3.52 | 3.05 | 3.97 | 3.44 | 4.57 | 3.96 |
| 122 | 2.12 | 1.80 | 2.27 | 1.92 | 2.43 | 2.06 | 2.63 | 2.23 | 2.86 | 2.43 | 3.14 | 2.66 | 3.49 | 2.96 | 3.93 | 3.33 |
| 124 | 2.00 | 1.65 | 2.12 | 1.76 | 2.26 | 1.87 | 2.42 | 2.01 | 2.61 | 2.16 | 2.84 | 2.35 | 3.11 | 2.58 | 3.45 | 2.86 |
| 126 | 1.88 | 1.52 | 1.99 | 1.61 | 2.11 | 1.71 | 2.25 | 1.82 | 2.40 | 1.95 | 2.59 | 2.10 | 2.81 | 2.27 | 3.08 | 2.49 |
| 128 | 1.78 | 1.41 | 1.88 | 1.48 | 1.98 | 1.56 | 2.10 | 1.65 | 2.23 | 1.76 | 2.39 | 1.88 | 2.57 | 2.02 | 2.78 | 2.19 |
| 130 | 1.70 | 1.30 | 1.78 | 1.36 | 1.87 | 1.43 | 1.97 | 1.51 | 2.08 | 1.60 | 2.21 | 1.70 | 2.36 | 1.81 | 2.54 | 1.94 |
| 132 | 1.62 | 1.20 | 1.69 | 1.26 | 1.77 | 1.32 | 1.86 | 1.38 | 1.96 | 1.45 | 2.07 | 1.54 | 2.19 | 1.63 | 2.34 | 1.74 |
| 134 | 1.55 | 1.12 | 1.62 | 1.16 | 1.68 | 1.21 | 1.76 | 1.27 | 1.85 | 1.33 | 1.94 | 1.40 | 2.05 | 1.47 | 2.17 | 1.56 |
| 136 | 1.49 | 1.04 | 1.55 | 1.07 | 1.61 | 1.12 | 1.68 | 1.16 | 1.75 | 1.22 | 1.83 | 1.27 | 1.92 | 1.34 | 2.03 | 1.41 |
| 138 | 1.44 | 0.96 | 1.49 | 0.99 | 1.54 | 1.03 | 1.60 | 1.07 | 1.66 | 1.11 | 1.74 | 1.16 | 1.81 | 1.21 | 1.90 | 1.27 |
| 140 | 1.39 | 0.89 | 1.43 | 0.92 | 1.48 | 0.95 | 1.53 | 0.98 | 1.59 | 1.02 | 1.65 | 1.06 | 1.72 | 1.10 | 1.79 | 1.15 |
| 142 | 1.34 | 0.83 | 1.38 | 0.85 | 1.43 | 0.88 | 1.47 | 0.91 | 1.52 | 0.94 | 1.58 | 0.97 | 1.64 | 1.01 | 1.70 | 1.05 |
| 144 | 1.30 | 0.77 | 1.34 | 0.79 | 1.38 | 0.81 | 1.42 | 0.83 | 1.46 | 0.86 | 1.51 | 0.89 | 1.56 | 0.92 | 1.62 | 0.95 |
| 146 | 1.27 | 0.71 | 1.30 | 0.73 | 1.33 | 0.75 | 1.37 | 0.77 | 1.41 | 0.79 | 1.45 | 0.81 | 1.50 | 0.84 | 1.54 | 0.86 |
| 148 | 1.23 | 0.65 | 1.26 | 0.67 | 1.29 | 0.69 | 1.33 | 0.70 | 1.36 | 0.72 | 1.40 | 0.74 | 1.44 | 0.76 | 1.48 | 0.78 |
| 150 | 1.20 | 0.60 | 1.23 | 0.61 | 1.26 | 0.63 | 1.29 | 0.64 | 1.32 | 0.66 | 1.35 | 0.67 | 1.38 | 0.69 | 1.42 | 0.71 |
| 152 | 1.18 | 0.55 | 1.20 | 0.56 | 1.22 | 0.57 | 1.25 | 0.59 | 1.28 | 0.60 | 1.31 | 0.61 | 1.34 | 0.63 | 1.37 | 0.64 |
| 154 | 1.15 | 0.50 | 1.17 | 0.51 | 1.19 | 0.52 | 1.22 | 0.53 | 1.24 | 0.54 | 1.27 | 0.56 | 1.29 | 0.57 | 1.32 | 0.58 |
| 156 | 1.13 | 0.46 | 1.15 | 0.47 | 1.17 | 0.47 | 1.19 | 0.48 | 1.21 | 0.49 | 1.23 | 0.50 | 1.25 | 0.51 | 1.28 | 0.52 |
| 158 | 1.11 | 0.42 | 1.13 | 0.42 | 1.14 | 0.43 | 1.16 | 0.44 | 1.18 | 0.44 | 1.20 | 0.45 | 1.22 | 0.46 | 1.24 | 0.47 |
| 160 | 1.09 | 0.37 | 1.11 | 0.38 | 1.12 | 0.38 | 1.14 | 0.39 | 1.15 | 0.39 | 1.17 | 0.40 | 1.19 | 0.41 | 1.21 | 0.41 |

# TABLE 5B.

Distance of an Object by Two Bearings.

| Difference between the course and second bearing. | Difference between the course and first bearing. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 110° | | 112° | | 114° | | 116° | | 118° | | 120° | | 122° |
| 120° | 5.41 | 4.69 | | | | | | | | | | | |
| 122 | 4.52 | 3.83 | 5.34 | 4.53 | | | | | | | | | |
| 124 | 3.88 | 3.22 | 4.46 | 3.70 | 5.26 | 4.36 | | | | | | | |
| 126 | 3.41 | 2.76 | 3.83 | 3.10 | 4.39 | 3.55 | 5.18 | 4.19 | | | | | |
| 128 | 3.04 | 2.40 | 3.36 | 2.65 | 3.78 | 2.98 | 4.32 | 3.41 | 5.08 | 4.01 | | | |
| 130 | 2.75 | 2.10 | 3.00 | 2.30 | 3.31 | 2.54 | 3.72 | 2.85 | 4.25 | 3.25 | 4.99 | 3.82 | |
| 132 | 2.51 | 1.86 | 2.71 | 2.01 | 2.96 | 2.20 | 3.26 | 2.42 | 3.65 | 2.71 | 4.17 | 3.10 | 4.88 3.63 |
| 134 | 2.31 | 1.66 | 2.48 | 1.78 | 2.67 | 1.92 | 2.91 | 2.09 | 3.20 | 2.30 | 3.58 | 2.57 | 4.08 2.93 |
| 136 | 2.14 | 1.49 | 2.28 | 1.58 | 2.44 | 1.69 | 2.63 | 1.83 | 2.86 | 1.98 | 3.14 | 2.18 | 3.51 2.44 |
| 138 | 2.00 | 1.34 | 2.12 | 1.42 | 2.25 | 1.50 | 2.40 | 1.61 | 2.58 | 1.73 | 2.80 | 1.88 | 3.08 2.06 |
| 140 | 1.88 | 1.21 | 1.97 | 1.27 | 2.08 | 1.34 | 2.21 | 1.42 | 2.36 | 1.52 | 2.53 | 1.63 | 2.74 1.76 |
| 142 | 1.77 | 1.09 | 1.85 | 1.14 | 1.95 | 1.20 | 2.05 | 1.26 | 2.17 | 1.34 | 2.31 | 1.42 | 2.48 1.53 |
| 144 | 1.68 | 0.99 | 1.75 | 1.03 | 1.83 | 1.07 | 1.91 | 1.13 | 2.01 | 1.18 | 2.13 | 1.25 | 2.26 1.33 |
| 146 | 1.60 | 0.89 | 1.66 | 0.93 | 1.72 | 0.96 | 1.80 | 1.01 | 1.88 | 1.05 | 1.98 | 1.10 | 2.08 1.17 |
| 148 | 1.53 | 0.81 | 1.58 | 0.84 | 1.63 | 0.87 | 1.70 | 0.90 | 1.77 | 0.94 | 1.84 | 0.98 | 1.93 1.03 |
| 150 | 1.46 | 0.73 | 1.51 | 0.75 | 1.55 | 0.78 | 1.61 | 0.80 | 1.67 | 0.83 | 1.73 | 0.87 | 1.81 0.90 |
| 152 | 1.40 | 0.66 | 1.44 | 0.68 | 1.48 | 0.70 | 1.53 | 0.72 | 1.58 | 0.74 | 1.63 | 0.77 | 1.70 0.80 |
| 154 | 1.35 | 0.59 | 1.39 | 0.61 | 1.42 | 0.62 | 1.46 | 0.64 | 1.50 | 0.66 | 1.55 | 0.68 | 1.60 0.70 |
| 156 | 1.31 | 0.53 | 1.33 | 0.54 | 1.37 | 0.56 | 1.40 | 0.57 | 1.43 | 0.58 | 1.47 | 0.60 | 1.52 0.62 |
| 158 | 1.26 | 0.47 | 1.29 | 0.48 | 1.32 | 0.49 | 1.34 | 0.50 | 1.37 | 0.51 | 1.41 | 0.53 | 1.44 0.54 |
| 160 | 1.23 | 0.42 | 1.25 | 0.43 | 1.27 | 0.43 | 1.29 | 0.44 | 1.32 | 0.45 | 1.35 | 0.46 | 1.38 0.47 |

| | 124° | | 126° | | 128° | | 130° | | 132° | | 134° | | 136° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 134° | 4.77 | 3.43 | | | | | | | | | | | |
| 136 | 3.99 | 2.77 | 4.66 | 3.23 | | | | | | | | | |
| 138 | 3.43 | 2.29 | 3.89 | 2.60 | 4.54 | 3.04 | | | | | | | |
| 140 | 3.01 | 1.93 | 3.34 | 2.15 | 3.79 | 2.44 | 4.41 | 2.84 | | | | | |
| 142 | 2.68 | 1.65 | 2.94 | 1.81 | 3.26 | 2.01 | 3.63 | 2.27 | 4.28 | 2.63 | | | |
| 144 | 2.42 | 1.42 | 2.62 | 1.54 | 2.86 | 1.68 | 3.17 | 1.86 | 3.57 | 2.10 | 4.14 | 2.43 | |
| 146 | 2.21 | 1.24 | 2.37 | 1.32 | 2.55 | 1.43 | 2.78 | 1.55 | 3.07 | 1.72 | 3.46 | 1.93 | 4.00 2.24 |
| 148 | 2.04 | 1.08 | 2.16 | 1.14 | 2.30 | 1.22 | 2.48 | 1.31 | 2.70 | 1.43 | 2.97 | 1.58 | 3.34 1.77 |
| 150 | 1.89 | 0.95 | 1.99 | 0.99 | 2.10 | 1.05 | 2.24 | 1.12 | 2.40 | 1.20 | 2.61 | 1.30 | 2.87 1.44 |
| 152 | 1.77 | 0.83 | 1.85 | 0.87 | 1.94 | 0.91 | 2.04 | 0.96 | 2.17 | 1.02 | 2.33 | 1.09 | 2.52 1.18 |
| 154 | 1.66 | 0.73 | 1.72 | 0.76 | 1.80 | 0.79 | 1.88 | 0.83 | 1.98 | 0.87 | 2.10 | 0.92 | 2.25 0.99 |
| 156 | 1.56 | 0.64 | 1.62 | 0.66 | 1.68 | 0.68 | 1.75 | 0.71 | 1.83 | 0.74 | 1.92 | 0.78 | 2.03 0.83 |
| 158 | 1.48 | 0.56 | 1.53 | 0.57 | 1.58 | 0.59 | 1.63 | 0.61 | 1.70 | 0.64 | 1.77 | 0.66 | 1.85 0.69 |
| 160 | 1.41 | 0.48 | 1.45 | 0.49 | 1.49 | 0.51 | 1.53 | 0.52 | 1.58 | 0.54 | 1.64 | 0.56 | 1.71 0.58 |

| | 138° | | 140° | | 142° | | 144° | | 146° | | 148° | | 150° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 148° | 3.85 | 2.04 | | | | | | | | | | | |
| 150 | 3.22 | 1.61 | 3.70 | 1.85 | | | | | | | | | |
| 152 | 2.77 | 1.30 | 3.09 | 1.45 | 3.55 | 1.66 | | | | | | | |
| 154 | 2.43 | 1.06 | 2.66 | 1.16 | 2.96 | 1.30 | 3.38 | 1.48 | | | | | |
| 156 | 2.17 | 0.88 | 2.33 | 0.95 | 2.54 | 1.04 | 2.83 | 1.15 | 3.22 | 1.31 | | | |
| 158 | 1.96 | 0.73 | 2.08 | 0.78 | 2.23 | 0.84 | 2.43 | 0.91 | 2.69 | 1.01 | 3.05 | 1.14 | |
| 160 | 1.79 | 0.61 | 1.88 | 0.64 | 1.99 | 0.68 | 2.13 | 0.73 | 2.31 | 0.79 | 2.55 | 0.87 | 2.88 0.98 |

TABLE 6. [Page 477

Distance of Visibility of Objects at Sea.

| Height, feet. | Nautical miles. | Statute miles. | Height, feet. | Nautical miles. | Statute miles. | Height, feet. | Nautical miles. | Statute miles. |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.1 | 1.3 | 100 | 11.5 | 13.2 | 760 | 31.6 | 36.4 |
| 2 | 1.7 | 1.9 | 105 | 11.7 | 13.5 | 780 | 32.0 | 36.9 |
| 3 | 2.0 | 2.3 | 110 | 12.0 | 13.8 | 800 | 32.4 | 37.3 |
| 4 | 2.3 | 2.6 | 115 | 12.3 | 14.1 | 820 | 32.8 | 37.8 |
| 5 | 2.5 | 2.9 | 120 | 12.6 | 14.5 | 840 | 33.2 | 38.3 |
| 6 | 2.8 | 3.2 | 125 | 12.9 | 14.8 | 860 | 33.6 | 38.7 |
| 7 | 2.9 | 3.5 | 130 | 13.1 | 15.1 | 880 | 34.0 | 39.2 |
| 8 | 3.1 | 3.7 | 135 | 13.3 | 15.3 | 900 | 34.4 | 39.6 |
| 9 | 3.5 | 4.0 | 140 | 13.6 | 15.6 | 920 | 34.7 | 40.0 |
| 10 | 3.6 | 4.2 | 145 | 13.8 | 15.9 | 940 | 35.2 | 40.5 |
| 11 | 3.8 | 4.4 | 150 | 14.1 | 16.2 | 960 | 35.5 | 40.9 |
| 12 | 4.0 | 4.6 | 160 | 14.5 | 16.7 | 980 | 35.9 | 41.3 |
| 13 | 4.2 | 4.8 | 170 | 14.9 | 17.2 | 1,000 | 36.2 | 41.7 |
| 14 | 4.3 | 4.9 | 180 | 15.4 | 17.7 | 1,100 | 38.0 | 43.8 |
| 15 | 4.4 | 5.1 | 190 | 15.8 | 18.2 | 1,200 | 39.6 | 45.6 |
| 16 | 4.6 | 5.3 | 200 | 16.2 | 18.7 | 1,300 | 41.3 | 47.6 |
| 17 | 4.7 | 5.4 | 210 | 16.6. | 19.1 | 1,400 | 42.9 | 49.4 |
| 18 | 4.9 | 5.6 | 220 | 17.0 | 19.6 | 1,500 | 44.4 | 51.1 |
| 19 | 5.0 | 5.8 | 230 | 17.4 | 20.0 | 1,600 | 45.8 | 52.8 |
| 20 | 5.1 | 5.9 | 240 | 17.7 | 20.4 | 1,700 | 47.2 | 54.4 |
| 21 | 5.3 | 6.1 | 250 | 18.2 | 20.9 | 1,800 | 48.6 | 56.0 |
| 22 | 5.4 | 6.2 | 260 | 18.5 | 21.3 | 1,900 | 49.9 | 57.5 |
| 23 | 5.5 | 6.3 | 270 | 18.9 | 21.7 | 2,000 | 51.2 | 59.0 |
| 24 | 5.6 | 6.5 | 280 | 19.2 | 22.1 | 2,100 | 52.5 | 60.5 |
| 25 | 5.7 | 6.6 | 290 | 19.6 | 22.5 | 2,200 | 53.8 | 61.9 |
| 26 | 5.8 | 6.7 | 300 | 19.9 | 22.9 | 2,300 | 55.0 | 63.3 |
| 27 | 6.0 | 6.9 | 310 | 20.1 | 23.2 | 2,400 | 56.2 | 64.7 |
| 28 | 6.1 | 7.0 | 320 | 20.5 | 23.6 | 2,500 | 57.3 | 66.0 |
| 29 | 6.2 | 7.1 | 330 | 20.8 | 24.0 | 2,600 | 58.5 | 67.3 |
| 30 | 6.3 | 7.2 | 340 | 21.1 | 24.3 | 2,700 | 59.6 | 68.6 |
| 31 | 6.4 | 7.3 | 350 | 21.5 | 24.7 | 2,800 | 60.6 | 69.8 |
| 32 | 6.5 | 7.5 | 360 | 21.7 | 25.0 | 2,900 | 61.8 | 71.1 |
| 33 | 6.6 | 7.6 | 370 | 22.1 | 25.4 | 3,000 | 62.8 | 72.3 |
| 34 | 6.7 | 7.7 | 380 | 22.3 | 25.7 | 3,100 | 63.8 | 73.5 |
| 35 | 6.8 | 7.8 | 390 | 22.7 | 26.1 | 3,200 | 64.9 | 74.7 |
| 36 | 6.9 | 7.9 | 400 | 22.9 | 26.4 | 3,300 | 65.9 | 75.9 |
| 37 | 6.9 | 8.0 | 410 | 23.2 | 26.7 | 3,400 | 66.9 | 77.0 |
| 38 | 7.0 | 8.1 | 420 | 23.5 | 27.1 | 3,500 | 67.8 | 78.1 |
| 39 | 7.1 | 8.2 | 430 | 23.8 | 27.4 | 3,600 | 68.8 | 79.2 |
| 40 | 7.2 | 8.3 | 440 | 24.1 | 27.7 | 3,700 | 69.7 | 80.3 |
| 41 | 7.3 | 8.4 | 450 | 24.3 | 28.0 | 3,800 | 70.7 | 81.4 |
| 42 | 7.4 | 8.5 | 460 | 24.6 | 28.3 | 3,900 | 71.6 | 82.4 |
| 43 | 7.5 | 8.7 | 470 | 24.8 | 28.6 | 4,000 | 72.5 | 83.5 |
| 44 | 7.6 | 8.8 | 480 | 25.1 | 28.9 | 4,100 | 73.4 | 84.5 |
| 45 | 7.7 | 8.9 | 490 | 25.4 | 29.2 | 4,200 | 74.3 | 85.6 |
| 46 | 7.8 | 9.0 | 500 | 25.6 | 29.5 | 4,300 | 75.2 | 86.6 |
| 47 | 7.9 | 9.0 | 520 | 26.1 | 30.1 | 4,400 | 76.1 | 87.6 |
| 48 | 7.9 | 9.1 | 540 | 26.7 | 30.7 | 4,500 | 76.9 | 88.5 |
| 49 | 8.0 | 9.2 | 560 | 27.1 | 31.2 | 4,600 | 77.7 | 89.5 |
| 50 | 8.1 | 9.3 | 580 | 27.6 | 31.8 | 4,700 | 78.6 | 90.5 |
| 55 | 8.5 | 9.8 | 600 | 28.0 | 32.3 | 4,800 | 79.4 | 91.4 |
| 60 | 8.9 | 10.2 | 620 | 28.6 | 32.9 | 4,900 | 80.2 | 92.4 |
| 65 | 9.2 | 10.6 | 640 | 29.0 | 33.4 | 5,000 | 81.0 | 93.3 |
| 70 | 9.6 | 11.0 | 660 | 29.4 | 33.9 | 6,000 | 88.8 | 102.2 |
| 75 | 9.9 | 11.4 | 680 | 29.9 | 34.4 | 7,000 | 96.0 | 110.5 |
| 80 | 10.3 | 11.8 | 700 | 30.3 | 34.9 | 8,000 | 102.6 | 118.1 |
| 85 | 10.6 | 12.2 | 720 | 30.7 | 35.4 | 9,000 | 108.7 | 125.2 |
| 90 | 10.9 | 12.5 | 740 | 31.1 | 35.9 | 10,000 | 114.6 | 132.0 |
| 95 | 11.2 | 12.9 | | | | | | |

# TABLE 7.

For converting Arc into Time, and the reverse.

| ° ' '' | H. M. / M. S. / S. (60ths) | ° ' '' | H. M. / M. S. / S. (60ths) | ° ' '' | H. M. / M. S. / S. (60ths) | ° ' '' | H. M. / M. S. / S. (60ths) | ° ' '' | H. M. / M. S. / S. (60ths) | ° ' '' | H. M. / M. S. / S. (60ths) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 4 | 61 | 4 4 | 121 | 8 4 | 181 | 12 4 | 241 | 16 4 | 301 | 20 4 |
| 2 | 0 8 | 62 | 4 8 | 122 | 8 8 | 182 | 12 8 | 242 | 16 8 | 302 | 20 8 |
| 3 | 0 12 | 63 | 4 12 | 123 | 8 12 | 183 | 12 12 | 243 | 16 12 | 303 | 20 12 |
| 4 | 0 16 | 64 | 4 16 | 124 | 8 16 | 184 | 12 16 | 244 | 16 16 | 304 | 20 16 |
| 5 | 0 20 | 65 | 4 20 | 125 | 8 20 | 185 | 12 20 | 245 | 16 20 | 305 | 20 20 |
| 6 | 0 24 | 66 | 4 24 | 126 | 8 24 | 186 | 12 24 | 246 | 16 24 | 306 | 20 24 |
| 7 | 0 28 | 67 | 4 28 | 127 | 8 28 | 187 | 12 28 | 247 | 16 28 | 307 | 20 28 |
| 8 | 0 32 | 68 | 4 32 | 128 | 8 32 | 188 | 12 32 | 248 | 16 32 | 308 | 20 32 |
| 9 | 0 36 | 69 | 4 36 | 129 | 8 36 | 189 | 12 36 | 249 | 16 36 | 309 | 20 36 |
| 10 | 0 40 | 70 | 4 40 | 130 | 8 40 | 190 | 12 40 | 250 | 16 40 | 310 | 20 40 |
| 11 | 0 44 | 71 | 4 44 | 131 | 8 44 | 191 | 12 44 | 251 | 16 44 | 311 | 20 44 |
| 12 | 0 48 | 72 | 4 48 | 132 | 8 48 | 192 | 12 48 | 252 | 16 48 | 312 | 20 48 |
| 13 | 0 52 | 73 | 4 52 | 133 | 8 52 | 193 | 12 52 | 253 | 16 52 | 313 | 20 52 |
| 14 | 0 56 | 74 | 4 56 | 134 | 8 56 | 194 | 12 56 | 254 | 16 56 | 314 | 20 56 |
| 15 | 1 0 | 75 | 5 0 | 135 | 9 0 | 195 | 13 0 | 255 | 17 0 | 315 | 21 0 |
| 16 | 1 4 | 76 | 5 4 | 136 | 9 4 | 196 | 13 4 | 256 | 17 4 | 316 | 21 4 |
| 17 | 1 8 | 77 | 5 8 | 137 | 9 8 | 197 | 13 8 | 257 | 17 8 | 317 | 21 8 |
| 18 | 1 12 | 78 | 5 12 | 138 | 9 12 | 198 | 13 12 | 258 | 17 12 | 318 | 21 12 |
| 19 | 1 16 | 79 | 5 16 | 139 | 9 16 | 199 | 13 16 | 259 | 17 16 | 319 | 21 16 |
| 20 | 1 20 | 80 | 5 20 | 140 | 9 20 | 200 | 13 20 | 260 | 17 20 | 320 | 21 20 |
| 21 | 1 24 | 81 | 5 24 | 141 | 9 24 | 201 | 13 24 | 261 | 17 24 | 321 | 21 24 |
| 22 | 1 28 | 82 | 5 28 | 142 | 9 28 | 202 | 13 28 | 262 | 17 28 | 322 | 21 28 |
| 23 | 1 32 | 83 | 5 32 | 143 | 9 32 | 203 | 13 32 | 263 | 17 32 | 323 | 21 32 |
| 24 | 1 36 | 84 | 5 36 | 144 | 9 36 | 204 | 13 36 | 264 | 17 36 | 324 | 21 36 |
| 25 | 1 40 | 85 | 5 40 | 145 | 9 40 | 205 | 13 40 | 265 | 17 40 | 325 | 21 40 |
| 26 | 1 44 | 86 | 5 44 | 146 | 9 44 | 206 | 13 44 | 266 | 17 44 | 326 | 21 44 |
| 27 | 1 48 | 87 | 5 48 | 147 | 9 48 | 207 | 13 48 | 267 | 17 48 | 327 | 21 48 |
| 28 | 1 52 | 88 | 5 52 | 148 | 9 52 | 208 | 13 52 | 268 | 17 52 | 328 | 21 52 |
| 29 | 1 56 | 89 | 5 56 | 149 | 9 56 | 209 | 13 56 | 269 | 17 56 | 329 | 21 56 |
| 30 | 2 0 | 90 | 6 0 | 150 | 10 0 | 210 | 14 0 | 270 | 18 0 | 330 | 22 0 |
| 31 | 2 4 | 91 | 6 4 | 151 | 10 4 | 211 | 14 4 | 271 | 18 4 | 331 | 22 4 |
| 32 | 2 8 | 92 | 6 8 | 152 | 10 8 | 212 | 14 8 | 272 | 18 8 | 332 | 22 8 |
| 33 | 2 12 | 93 | 6 12 | 153 | 10 12 | 213 | 14 12 | 273 | 18 12 | 333 | 22 12 |
| 34 | 2 16 | 94 | 6 16 | 154 | 10 16 | 214 | 14 16 | 274 | 18 16 | 334 | 22 16 |
| 35 | 2 20 | 95 | 6 20 | 155 | 10 20 | 215 | 14 20 | 275 | 18 20 | 335 | 22 20 |
| 36 | 2 24 | 96 | 6 24 | 156 | 10 24 | 216 | 14 24 | 276 | 18 24 | 336 | 22 24 |
| 37 | 2 28 | 97 | 6 28 | 157 | 10 28 | 217 | 14 28 | 277 | 18 28 | 337 | 22 28 |
| 38 | 2 32 | 98 | 6 32 | 158 | 10 32 | 218 | 14 32 | 278 | 18 32 | 338 | 22 32 |
| 39 | 2 36 | 99 | 6 36 | 159 | 10 36 | 219 | 14 36 | 279 | 18 36 | 339 | 22 36 |
| 40 | 2 40 | 100 | 6 40 | 160 | 10 40 | 220 | 14 40 | 280 | 18 40 | 340 | 22 40 |
| 41 | 2 44 | 101 | 6 44 | 161 | 10 44 | 221 | 14 44 | 281 | 18 44 | 341 | 22 44 |
| 42 | 2 48 | 102 | 6 48 | 162 | 10 48 | 222 | 14 48 | 282 | 18 48 | 342 | 22 48 |
| 43 | 2 52 | 103 | 6 52 | 163 | 10 52 | 223 | 14 52 | 283 | 18 52 | 343 | 22 52 |
| 44 | 2 56 | 104 | 6 56 | 164 | 10 56 | 224 | 14 56 | 284 | 18 56 | 344 | 22 56 |
| 45 | 3 0 | 105 | 7 0 | 165 | 11 0 | 225 | 15 0 | 285 | 19 0 | 345 | 23 0 |
| 46 | 3 4 | 106 | 7 4 | 166 | 11 4 | 226 | 15 4 | 286 | 19 4 | 346 | 23 4 |
| 47 | 3 8 | 107 | 7 8 | 167 | 11 8 | 227 | 15 8 | 287 | 19 8 | 347 | 23 8 |
| 48 | 3 12 | 108 | 7 12 | 168 | 11 12 | 228 | 15 12 | 288 | 19 12 | 348 | 23 12 |
| 49 | 3 16 | 109 | 7 16 | 169 | 11 16 | 229 | 15 16 | 289 | 19 16 | 349 | 23 16 |
| 50 | 3 20 | 110 | 7 20 | 170 | 11 20 | 230 | 15 20 | 290 | 19 20 | 350 | 23 20 |
| 51 | 3 24 | 111 | 7 24 | 171 | 11 24 | 231 | 15 24 | 291 | 19 24 | 351 | 23 24 |
| 52 | 3 28 | 112 | 7 28 | 172 | 11 28 | 232 | 15 28 | 292 | 19 28 | 352 | 23 28 |
| 53 | 3 32 | 113 | 7 32 | 173 | 11 32 | 233 | 15 32 | 293 | 19 32 | 353 | 23 32 |
| 54 | 3 36 | 114 | 7 36 | 174 | 11 36 | 234 | 15 36 | 294 | 19 36 | 354 | 23 36 |
| 55 | 3 40 | 115 | 7 40 | 175 | 11 40 | 235 | 15 40 | 295 | 19 40 | 355 | 23 40 |
| 56 | 3 44 | 116 | 7 44 | 176 | 11 44 | 236 | 15 44 | 296 | 19 44 | 356 | 23 44 |
| 57 | 3 48 | 117 | 7 48 | 177 | 11 48 | 237 | 15 48 | 297 | 19 48 | 357 | 23 48 |
| 58 | 3 52 | 118 | 7 52 | 178 | 11 52 | 238 | 15 52 | 298 | 19 52 | 358 | 23 52 |
| 59 | 3 56 | 119 | 7 56 | 179 | 11 56 | 239 | 15 56 | 299 | 19 56 | 359 | 23 56 |
| 60 | 4 0 | 120 | 8 0 | 180 | 12 0 | 240 | 16 0 | 300 | 20 0 | 360 | 24 0 |

NOTE.—When turning seconds of arc into time, and vice versa, it should be remembered that the fractions are sixtieths; thus, the value in time of 42″ is not 2ˢ.48, but 2ˢ$\frac{48}{60}$=2ˢ.8.

# TABLE 8.

[Page 479
### Sidereal into Mean Solar Time.

To be subtracted from a sidereal time interval.

| Sidereal | 0ʰ | 1ʰ | 2ʰ | 3ʰ | 4ʰ | 5ʰ | 6ʰ | 7ʰ | For seconds. | |
|---|---|---|---|---|---|---|---|---|---|---|
| m. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | s. | s. |
| 0 | 0 0.000 | 0 9.830 | 0 19.659 | 0 29.489 | 0 39.318 | 0 49.148 | 0 58.977 | 1 8.807 | | |
| 1 | 0 0.164 | 0 9.993 | 0 19.823 | 0 29.653 | 0 39.482 | 0 49.312 | 0 59.141 | 1 8.971 | 1 | 0.003 |
| 2 | 0 0.328 | 0 10.157 | 0 19.987 | 0 29.816 | 0 39.646 | 0 49.475 | 0 59.305 | 1 9.135 | 2 | .005 |
| 3 | 0 0.491 | 0 10.321 | 0 20.151 | 0 29.980 | 0 39.810 | 0 49.639 | 0 59.469 | 1 9.298 | 3 | .008 |
| 4 | 0 0.655 | 0 10.485 | 0 20.314 | 0 30.144 | 0 39.974 | 0 49.803 | 0 59.633 | 1 9.462 | 4 | .011 |
| 5 | 0 0.819 | 0 10.649 | 0 20.478 | 0 30.308 | 0 40.137 | 0 49.967 | 0 59.796 | 1 9.626 | 5 | .014 |
| 6 | 0 0.983 | 0 10.813 | 0 20.642 | 0 30.472 | 0 40.301 | 0 50.131 | 0 59.960 | 1 9.790 | 6 | .016 |
| 7 | 0 1.147 | 0 10.976 | 0 20.806 | 0 30.635 | 0 40.465 | 0 50.295 | 1 0.124 | 1 9.954 | 7 | .019 |
| 8 | 0 1.311 | 0 11.140 | 0 20.970 | 0 30.799 | 0 40.629 | 0 50.458 | 1 0.288 | 1 10.118 | 8 | .022 |
| 9 | 0 1.474 | 0 11.304 | 0 21.134 | 0 30.963 | 0 40.793 | 0 50.622 | 1 0.452 | 1 10.281 | 9 | .025 |
| 10 | 0 1.638 | 0 11.468 | 0 21.297 | 0 31.127 | 0 40.956 | 0 50.786 | 1 0.616 | 1 10.445 | 10 | .027 |
| 11 | 0 1.802 | 0 11.632 | 0 21.461 | 0 31.291 | 0 41.120 | 0 50.950 | 1 0.779 | 1 10.609 | 11 | .030 |
| 12 | 0 1.966 | 0 11.795 | 0 21.625 | 0 31.455 | 0 41.284 | 0 51.114 | 1 0.943 | 1 10.773 | 12 | .033 |
| 13 | 0 2.130 | 0 11.959 | 0 21.789 | 0 31.618 | 0 41.448 | 0 51.278 | 1 1.107 | 1 10.937 | 13 | .035 |
| 14 | 0 2.294 | 0 12.123 | 0 21.953 | 0 31.782 | 0 41.612 | 0 51.441 | 1 1.271 | 1 11.100 | 14 | .038 |
| 15 | 0 2.457 | 0 12.287 | 0 22.117 | 0 31.946 | 0 41.776 | 0 51.605 | 1 1.435 | 1 11.264 | 15 | .041 |
| 16 | 0 2.621 | 0 12.451 | 0 22.280 | 0 32.110 | 0 41.939 | 0 51.769 | 1 1.599 | 1 11.428 | 16 | .044 |
| 17 | 0 2.785 | 0 12.615 | 0 22.444 | 0 32.274 | 0 42.103 | 0 51.933 | 1 1.762 | 1 11.592 | 17 | .046 |
| 18 | 0 2.949 | 0 12.778 | 0 22.608 | 0 32.438 | 0 42.267 | 0 52.097 | 1 1.926 | 1 11.756 | 18 | .049 |
| 19 | 0 3.113 | 0 12.942 | 0 22.772 | 0 32.601 | 0 42.431 | 0 52.260 | 1 2.090 | 1 11.920 | 19 | .052 |
| 20 | 0 3.277 | 0 13.106 | 0 22.936 | 0 32.765 | 0 42.595 | 0 52.424 | 1 2.254 | 1 12.083 | 20 | .055 |
| 21 | 0 3.440 | 0 13.270 | 0 23.099 | 0 32.929 | 0 42.759 | 0 52.588 | 1 2.418 | 1 12.247 | 21 | .057 |
| 22 | 0 3.604 | 0 13.434 | 0 23.263 | 0 33.093 | 0 42.922 | 0 52.752 | 1 2.582 | 1 12.411 | 22 | .060 |
| 23 | 0 3.768 | 0 13.598 | 0 23.427 | 0 33.257 | 0 43.086 | 0 52.916 | 1 2.745 | 1 12.575 | 23 | .063 |
| 24 | 0 3.932 | 0 13.761 | 0 23.591 | 0 33.420 | 0 43.250 | 0 53.080 | 1 2.909 | 1 12.739 | 24 | .066 |
| 25 | 0 4.096 | 0 13.925 | 0 23.755 | 0 33.584 | 0 43.414 | 0 53.243 | 1 3.073 | 1 12.903 | 25 | .068 |
| 26 | 0 4.259 | 0 14.089 | 0 23.919 | 0 33.748 | 0 43.578 | 0 53.407 | 1 3.237 | 1 13.066 | 26 | .071 |
| 27 | 0 4.423 | 0 14.253 | 0 24.082 | 0 33.912 | 0 43.742 | 0 53.571 | 1 3.401 | 1 13.230 | 27 | .074 |
| 28 | 0 4.587 | 0 14.417 | 0 24.246 | 0 34.076 | 0 43.905 | 0 53.735 | 1 3.564 | 1 13.394 | 28 | .076 |
| 29 | 0 4.751 | 0 14.581 | 0 24.410 | 0 34.240 | 0 44.069 | 0 53.899 | 1 3.728 | 1 13.558 | 29 | .079 |
| 30 | 0 4.915 | 0 14.744 | 0 24.574 | 0 34.403 | 0 44.233 | 0 54.063 | 1 3.892 | 1 13.722 | 30 | .082 |
| 31 | 0 5.079 | 0 14.908 | 0 24.738 | 0 34.567 | 0 44.397 | 0 54.226 | 1 4.056 | 1 13.886 | 31 | .085 |
| 32 | 0 5.242 | 0 15.072 | 0 24.902 | 0 34.731 | 0 44.561 | 0 54.390 | 1 4.220 | 1 14.049 | 32 | .087 |
| 33 | 0 5.406 | 0 15.236 | 0 25.065 | 0 34.895 | 0 44.724 | 0 54.554 | 1 4.384 | 1 14.213 | 33 | .090 |
| 34 | 0 5.570 | 0 15.400 | 0 25.229 | 0 35.059 | 0 44.888 | 0 54.718 | 1 4.547 | 1 14.377 | 34 | .093 |
| 35 | 0 5.734 | 0 15.563 | 0 25.393 | 0 35.223 | 0 45.052 | 0 54.882 | 1 4.711 | 1 14.541 | 35 | .096 |
| 36 | 0 5.898 | 0 15.727 | 0 25.557 | 0 35.386 | 0 45.216 | 0 55.046 | 1 4.875 | 1 14.705 | 36 | .098 |
| 37 | 0 6.062 | 0 15.891 | 0 25.721 | 0 35.550 | 0 45.380 | 0 55.209 | 1 5.039 | 1 14.868 | 37 | .101 |
| 38 | 0 6.225 | 0 16.055 | 0 25.885 | 0 35.714 | 0 45.544 | 0 55.373 | 1 5.203 | 1 15.032 | 38 | .104 |
| 39 | 0 6.389 | 0 16.219 | 0 26.048 | 0 35.878 | 0 45.707 | 0 55.537 | 1 5.367 | 1 15.196 | 39 | .106 |
| 40 | 0 6.553 | 0 16.383 | 0 26.212 | 0 36.042 | 0 45.871 | 0 55.701 | 1 5.530 | 1 15.360 | 40 | .109 |
| 41 | 0 6.717 | 0 16.546 | 0 26.376 | 0 36.206 | 0 46.035 | 0 55.865 | 1 5.694 | 1 15.524 | 41 | .112 |
| 42 | 0 6.881 | 0 16.710 | 0 26.540 | 0 36.369 | 0 46.199 | 0 56.028 | 1 5.858 | 1 15.688 | 42 | .115 |
| 43 | 0 7.045 | 0 16.874 | 0 26.704 | 0 36.533 | 0 46.363 | 0 56.192 | 1 6.022 | 1 15.851 | 43 | .117 |
| 44 | 0 7.208 | 0 17.038 | 0 26.867 | 0 36.697 | 0 46.527 | 0 56.356 | 1 6.186 | 1 16.015 | 44 | .120 |
| 45 | 0 7.372 | 0 17.202 | 0 27.031 | 0 36.861 | 0 46.690 | 0 56.520 | 1 6.350 | 1 16.179 | 45 | .123 |
| 46 | 0 7.536 | 0 17.366 | 0 27.195 | 0 37.025 | 0 46.854 | 0 56.684 | 1 6.513 | 1 16.343 | 46 | .126 |
| 47 | 0 7.700 | 0 17.529 | 0 27.359 | 0 37.188 | 0 47.018 | 0 56.848 | 1 6.677 | 1 16.507 | 47 | .128 |
| 48 | 0 7.864 | 0 17.693 | 0 27.523 | 0 37.352 | 0 47.182 | 0 57.011 | 1 6.841 | 1 16.671 | 48 | .131 |
| 49 | 0 8.027 | 0 17.857 | 0 27.687 | 0 37.516 | 0 47.346 | 0 57.175 | 1 7.005 | 1 16.834 | 49 | .134 |
| 50 | 0 8.191 | 0 18.021 | 0 27.850 | 0 37.680 | 0 47.510 | 0 57.339 | 1 7.169 | 1 16.998 | 50 | .137 |
| 51 | 0 8.355 | 0 18.185 | 0 28.014 | 0 37.844 | 0 47.673 | 0 57.503 | 1 7.332 | 1 17.162 | 51 | .139 |
| 52 | 0 8.519 | 0 18.349 | 0 28.178 | 0 38.008 | 0 47.837 | 0 57.667 | 1 7.496 | 1 17.326 | 52 | .142 |
| 53 | 0 8.683 | 0 18.512 | 0 28.342 | 0 38.171 | 0 48.001 | 0 57.831 | 1 7.660 | 1 17.490 | 53 | .145 |
| 54 | 0 8.847 | 0 18.676 | 0 28.506 | 0 38.335 | 0 48.165 | 0 57.994 | 1 7.824 | 1 17.654 | 54 | .147 |
| 55 | 0 9.010 | 0 18.840 | 0 28.670 | 0 38.499 | 0 48.329 | 0 58.158 | 1 7.988 | 1 17.817 | 55 | .150 |
| 56 | 0 9.174 | 0 19.004 | 0 28.833 | 0 38.663 | 0 48.492 | 0 58.322 | 1 8.152 | 1 17.981 | 56 | .153 |
| 57 | 0 9.338 | 0 19.168 | 0 28.997 | 0 38.827 | 0 48.656 | 0 58.486 | 1 8.315 | 1 18.145 | 57 | .156 |
| 58 | 0 9.502 | 0 19.331 | 0 29.161 | 0 38.991 | 0 48.820 | 0 58.650 | 1 8.479 | 1 18.309 | 58 | .158 |
| 59 | 0 9.666 | 0 19.495 | 0 29.325 | 0 39.154 | 0 48.984 | 0 58.814 | 1 8.643 | 1 18.473 | 59 | 0.161 |

# TABLE 8.

### Sidereal into Mean Solar Time.

To be subtracted from a sidereal time interval.

| Sidereal. | 8ʰ | 9ʰ | 10ʰ | 11ʰ | 12ʰ | 13ʰ | 14ʰ | 15ʰ | For seconds. | |
|---|---|---|---|---|---|---|---|---|---|---|
| *m.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *s.* | *s.* |
| 0 | 1 18.636 | 1 28.466 | 1 38.296 | 1 48.125 | 1 57.955 | 2 7.784 | 2 17.614 | 2 27.443 | | |
| 1 | 1 18.800 | 1 28.630 | 1 38.459 | 1 48.289 | 1 58.119 | 2 7.948 | 2 17.778 | 2 27.607 | 1 | 0.003 |
| 2 | 1 18.964 | 1 28.794 | 1 38.623 | 1 48.453 | 1 58.282 | 2 8.112 | 2 17.941 | 2 27.771 | 2 | .005 |
| 3 | 1 19.128 | 1 28.958 | 1 38.787 | 1 48.617 | 1 58.446 | 2 8.276 | 2 18.105 | 2 27.935 | 3 | .008 |
| 4 | 1 19.292 | 1 29.121 | 1 38.951 | 1 48.780 | 1 58.610 | 2 8.440 | 2 18.269 | 2 28.099 | 4 | .011 |
| 5 | 1 19.456 | 1 29.285 | 1 39.115 | 1 48.944 | 1 58.774 | 2 8.603 | 2 18.433 | 2 28.263 | 5 | .014 |
| 6 | 1 19.619 | 1 29.449 | 1 39.279 | 1 49.108 | 1 58.938 | 2 8.767 | 2 18.597 | 2 28.426 | 6 | .016 |
| 7 | 1 19.783 | 1 29.613 | 1 39.442 | 1 49.272 | 1 59.101 | 2 8.931 | 2 18.761 | 2 28.590 | 7 | .019 |
| 8 | 1 19.947 | 1 29.777 | 1 39.606 | 1 49.436 | 1 59.265 | 2 9.095 | 2 18.924 | 2 28.754 | 8 | .022 |
| 9 | 1 20.111 | 1 29.940 | 1 39.770 | 1 49.600 | 1 59.429 | 2 9.259 | 2 19.088 | 2 28.918 | 9 | .025 |
| 10 | 1 20.275 | 1 30.104 | 1 39.934 | 1 49.763 | 1 59.593 | 2 9.423 | 2 19.252 | 2 29.082 | 10 | .027 |
| 11 | 1 20.439 | 1 30.268 | 1 40.098 | 1 49.927 | 1 59.757 | 2 9.586 | 2 19.416 | 2 29.245 | 11 | .030 |
| 12 | 1 20.602 | 1 30.432 | 1 40.261 | 1 50.091 | 1 59.921 | 2 9.750 | 2 19.580 | 2 29.409 | 12 | .033 |
| 13 | 1 20.766 | 1 30.596 | 1 40.425 | 1 50.255 | 2 0.084 | 2 9.914 | 2 19.744 | 2 29.573 | 13 | .035 |
| 14 | 1 20.930 | 1 30.760 | 1 40.589 | 1 50.419 | 2 0.248 | 2 10.078 | 2 19.907 | 2 29.737 | 14 | .038 |
| 15 | 1 21.094 | 1 30.923 | 1 40.753 | 1 50.583 | 2 0.412 | 2 10.242 | 2 20.071 | 2 29.901 | 15 | .041 |
| 16 | 1 21.258 | 1 31.087 | 1 40.917 | 1 50.746 | 2 0.576 | 2 10.405 | 2 20.235 | 2 30.065 | 16 | .044 |
| 17 | 1 21.422 | 1 31.251 | 1 41.081 | 1 50.910 | 2 0.740 | 2 10.569 | 2 20.399 | 2 30.228 | 17 | .046 |
| 18 | 1 21.585 | 1 31.415 | 1 41.244 | 1 51.074 | 2 0.904 | 2 10.733 | 2 20.563 | 2 30.392 | 18 | .049 |
| 19 | 1 21.749 | 1 31.579 | 1 41.408 | 1 51.238 | 2 1.067 | 2 10.897 | 2 20.727 | 2 30.556 | 19 | .052 |
| 20 | 1 21.913 | 1 31.743 | 1 41.572 | 1 51.402 | 2 1.231 | 2 11.061 | 2 20.890 | 2 30.720 | 20 | .055 |
| 21 | 1 22.077 | 1 31.906 | 1 41.736 | 1 51.565 | 2 1.395 | 2 11.225 | 2 21.054 | 2 30.884 | 21 | .057 |
| 22 | 1 22.241 | 1 32.070 | 1 41.900 | 1 51.729 | 2 1.559 | 2 11.388 | 2 21.218 | 2 31.048 | 22 | .060 |
| 23 | 1 22.404 | 1 32.234 | 1 42.064 | 1 51.893 | 2 1.723 | 2 11.552 | 2 21.382 | 2 31.211 | 23 | .063 |
| 24 | 1 22.568 | 1 32.398 | 1 42.227 | 1 52.057 | 2 1.887 | 2 11.716 | 2 21.546 | 2 31.375 | 24 | .066 |
| 25 | 1 22.732 | 1 32.562 | 1 42.391 | 1 52.221 | 2 2.050 | 2 11.880 | 2 21.709 | 2 31.539 | 25 | .068 |
| 26 | 1 22.896 | 1 32.726 | 1 42.555 | 1 52.385 | 2 2.214 | 2 12.044 | 2 21.873 | 2 31.703 | 26 | .071 |
| 27 | 1 23.060 | 1 32.889 | 1 42.719 | 1 52.548 | 2 2.378 | 2 12.208 | 2 22.037 | 2 31.867 | 27 | .074 |
| 28 | 1 23.224 | 1 33.053 | 1 42.883 | 1 52.712 | 2 2.542 | 2 12.371 | 2 22.201 | 2 32.031 | 28 | .076 |
| 29 | 1 23.387 | 1 33.217 | 1 43.047 | 1 52.876 | 2 2.706 | 2 12.535 | 2 22.365 | 2 32.194 | 29 | .079 |
| 30 | 1 23.551 | 1 33.381 | 1 43.210 | 1 53.040 | 2 2.869 | 2 12.699 | 2 22.529 | 2 32.358 | 30 | .082 |
| 31 | 1 23.715 | 1 33.545 | 1 43.374 | 1 53.204 | 2 3.033 | 2 12.863 | 2 22.692 | 2 32.522 | 31 | .085 |
| 32 | 1 23.879 | 1 33.708 | 1 43.538 | 1 53.368 | 2 3.197 | 2 13.027 | 2 22.856 | 2 32.686 | 32 | .087 |
| 33 | 1 24.043 | 1 33.872 | 1 43.702 | 1 53.531 | 2 3.361 | 2 13.191 | 2 23.020 | 2 32.850 | 33 | .090 |
| 34 | 1 24.207 | 1 34.036 | 1 43.866 | 1 53.695 | 2 3.525 | 2 13.354 | 2 23.184 | 2 33.013 | 34 | .093 |
| 35 | 1 24.370 | 1 34.200 | 1 44.029 | 1 53.859 | 2 3.689 | 2 13.518 | 2 23.348 | 2 33.177 | 35 | .096 |
| 36 | 1 24.534 | 1 34.364 | 1 44.193 | 1 54.023 | 2 3.852 | 2 13.682 | 2 23.512 | 2 33.341 | 36 | .098 |
| 37 | 1 24.698 | 1 34.528 | 1 44.357 | 1 54.187 | 2 4.016 | 2 13.846 | 2 23.675 | 2 33.505 | 37 | .101 |
| 38 | 1 24.862 | 1 34.691 | 1 44.521 | 1 54.351 | 2 4.180 | 2 14.010 | 2 23.839 | 2 33.669 | 38 | .104 |
| 39 | 1 25.026 | 1 34.855 | 1 44.685 | 1 54.514 | 2 4.344 | 2 14.173 | 2 24.003 | 2 33.833 | 39 | .106 |
| 40 | 1 25.190 | 1 35.019 | 1 44.849 | 1 54.678 | 2 4.508 | 2 14.337 | 2 24.167 | 2 33.996 | 40 | .109 |
| 41 | 1 25.353 | 1 35.183 | 1 45.012 | 1 54.842 | 2 4.672 | 2 14.501 | 2 24.331 | 2 34.160 | 41 | .112 |
| 42 | 1 25.517 | 1 35.347 | 1 45.176 | 1 55.006 | 2 4.835 | 2 14.665 | 2 24.495 | 2 34.324 | 42 | .115 |
| 43 | 1 25.681 | 1 35.511 | 1 45.340 | 1 55.170 | 2 4.999 | 2 14.829 | 2 24.658 | 2 34.488 | 43 | .117 |
| 44 | 1 25.845 | 1 35.674 | 1 45.504 | 1 55.333 | 2 5.163 | 2 14.993 | 2 24.822 | 2 34.652 | 44 | .120 |
| 45 | 1 26.009 | 1 35.838 | 1 45.668 | 1 55.497 | 2 5.327 | 2 15.156 | 2 24.986 | 2 34.816 | 45 | .123 |
| 46 | 1 26.172 | 1 36.002 | 1 45.832 | 1 55.661 | 2 5.491 | 2 15.320 | 2 25.150 | 2 34.979 | 46 | .126 |
| 47 | 1 26.336 | 1 36.166 | 1 45.995 | 1 55.825 | 2 5.655 | 2 15.484 | 2 25.314 | 2 35.143 | 47 | .128 |
| 48 | 1 26.500 | 1 36.330 | 1 46.159 | 1 55.989 | 2 5.818 | 2 15.648 | 2 25.477 | 2 35.307 | 48 | .131 |
| 49 | 1 26.664 | 1 36.493 | 1 46.323 | 1 56.153 | 2 5.982 | 2 15.812 | 2 25.641 | 2 35.471 | 49 | .134 |
| 50 | 1 26.828 | 1 36.657 | 1 46.487 | 1 56.316 | 2 6.146 | 2 15.976 | 2 25.805 | 2 35.635 | 50 | .137 |
| 51 | 1 26.992 | 1 36.821 | 1 46.651 | 1 56.480 | 2 6.310 | 2 16.139 | 2 25.969 | 2 35.798 | 51 | .139 |
| 52 | 1 27.155 | 1 36.985 | 1 46.815 | 1 56.644 | 2 6.474 | 2 16.303 | 2 26.133 | 2 35.962 | 52 | .142 |
| 53 | 1 27.319 | 1 37.149 | 1 46.978 | 1 56.808 | 2 6.637 | 2 16.467 | 2 26.297 | 2 36.126 | 53 | .145 |
| 54 | 1 27.483 | 1 37.313 | 1 47.142 | 1 56.972 | 2 6.801 | 2 16.631 | 2 26.460 | 2 36.290 | 54 | .147 |
| 55 | 1 27.647 | 1 37.476 | 1 47.306 | 1 57.136 | 2 6.965 | 2 16.795 | 2 26.624 | 2 36.454 | 55 | .150 |
| 56 | 1 27.811 | 1 37.640 | 1 47.470 | 1 57.299 | 2 7.129 | 2 16.959 | 2 26.788 | 2 36.618 | 56 | .153 |
| 57 | 1 27.975 | 1 37.804 | 1 47.634 | 1 57.463 | 2 7.293 | 2 17.122 | 2 26.952 | 2 36.781 | 57 | .156 |
| 58 | 1 28.138 | 1 37.968 | 1 47.797 | 1 57.627 | 2 7.457 | 2 17.286 | 2 27.116 | 2 36.945 | 58 | .158 |
| 59 | 1 28.302 | 1 38.132 | 1 47.961 | 1 57.791 | 2 7.620 | 2 17.450 | 2 27.280 | 2 37.109 | 59 | 0.161 |

TABLE 8. [Page 481

## Sidereal into Mean Solar Time.

### To be subtracted from a sidereal time interval.

| Sidereal | 16ʰ | 17ʰ | 18ʰ | 19ʰ | 20ʰ | 21ʰ | 22ʰ | 23ʰ | For seconds. | |
|---|---|---|---|---|---|---|---|---|---|---|
| m. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | s. | s. |
| 0 | 2 37.273 | 2 47.102 | 2 56.932 | 3 6.762 | 3 16.591 | 3 26.421 | 3 36.250 | 3 46.080 | | |
| 1 | 2 37.437 | 2 47.266 | 2 57.096 | 3 6.925 | 3 16.755 | 3 26.585 | 3 36.414 | 3 46.244 | 1 | 0.003 |
| 2 | 2 37.601 | 2 47.430 | 2 57.260 | 3 7.089 | 3 16.919 | 3 26.748 | 3 36.578 | 3 46.407 | 2 | .005 |
| 3 | 2 37.764 | 2 47.594 | 2 57.424 | 3 7.253 | 3 17.083 | 3 26.912 | 3 36.742 | 3 46.571 | 3 | .008 |
| 4 | 2 37.928 | 2 47.758 | 2 57.587 | 3 7.417 | 3 17.246 | 3 27.076 | 3 36.906 | 3 46.735 | 4 | .011 |
| 5 | 2 38.092 | 2 47.922 | 2 57.751 | 3 7.581 | 3 17.410 | 3 27.240 | 3 37.069 | 3 46.899 | 5 | .014 |
| 6 | 2 38.256 | 2 48.085 | 2 57.915 | 3 7.745 | 3 17.574 | 3 27.404 | 3 37.233 | 3 47.063 | 6 | .016 |
| 7 | 2 38.420 | 2 48.249 | 2 58.079 | 3 7.908 | 3 17.738 | 3 27.568 | 3 37.397 | 3 47.227 | 7 | .019 |
| 8 | 2 38.584 | 2 48.413 | 2 58.243 | 3 8.072 | 3 17.902 | 3 27.731 | 3 37.561 | 3 47.390 | 8 | .022 |
| 9 | 2 38.747 | 2 48.577 | 2 58.406 | 3 8.236 | 3 18.066 | 3 27.895 | 3 37.725 | 3 47.554 | 9 | .025 |
| 10 | 2 38.911 | 2 48.741 | 2 58.570 | 3 8.400 | 3 18.229 | 3 28.059 | 3 37.889 | 3 47.718 | 10 | .027 |
| 11 | 2 39.075 | 2 48.905 | 2 58.734 | 3 8.564 | 3 18.393 | 3 28.223 | 3 38.052 | 3 47.882 | 11 | .030 |
| 12 | 2 39.239 | 2 49.068 | 2 58.898 | 3 8.728 | 3 18.557 | 3 28.387 | 3 38.216 | 3 48.046 | 12 | .033 |
| 13 | 2 39.403 | 2 49.232 | 2 59.062 | 3 8.891 | 3 18.721 | 3 28.550 | 3 38.380 | 3 48.210 | 13 | .035 |
| 14 | 2 39.566 | 2 49.396 | 2 59.226 | 3 9.055 | 3 18.885 | 3 28.714 | 3 38.544 | 3 48.373 | 14 | .038 |
| 15 | 2 39.730 | 2 49.560 | 2 59.389 | 3 9.219 | 3 19.049 | 3 28.878 | 3 38.708 | 3 48.537 | 15 | .041 |
| 16 | 2 39.894 | 2 49.724 | 2 59.553 | 3 9.383 | 3 19.212 | 3 29.042 | 3 38.871 | 3 48.701 | 16 | .044 |
| 17 | 2 40.058 | 2 49.888 | 2 59.717 | 3 9.547 | 3 19.376 | 3 29.206 | 3 39.035 | 3 48.865 | 17 | .046 |
| 18 | 2 40.222 | 2 50.051 | 2 59.881 | 3 9.710 | 3 19.540 | 3 29.370 | 3 39.199 | 3 49.029 | 18 | .049 |
| 19 | 2 40.386 | 2 50.215 | 3 0.045 | 3 9.874 | 3 19.704 | 3 29.533 | 3 39.363 | 3 49.193 | 19 | .052 |
| 20 | 2 40.549 | 2 50.379 | 3 0.209 | 3 10.038 | 3 19.868 | 3 29.697 | 3 39.527 | 3 49.356 | 20 | .055 |
| 21 | 2 40.713 | 2 50.543 | 3 0.372 | 3 10.202 | 3 20.032 | 3 29.861 | 3 39.691 | 3 49.520 | 21 | .057 |
| 22 | 2 40.877 | 2 50.707 | 3 0.536 | 3 10.366 | 3 20.195 | 3 30.025 | 3 39.854 | 3 49.684 | 22 | .060 |
| 23 | 2 41.041 | 2 50.870 | 3 0.700 | 3 10.530 | 3 20.359 | 3 30.189 | 3 40.018 | 3 49.848 | 23 | .063 |
| 24 | 2 41.205 | 2 51.034 | 3 0.864 | 3 10.693 | 3 20.523 | 3 30.353 | 3 40.182 | 3 50.012 | 24 | .066 |
| 25 | 2 41.369 | 2 51.198 | 3 1.028 | 3 10.857 | 3 20.687 | 3 30.516 | 3 40.346 | 3 50.175 | 25 | .068 |
| 26 | 2 41.532 | 2 51.362 | 3 1.192 | 3 11.021 | 3 20.851 | 3 30.680 | 3 40.510 | 3 50.339 | 26 | .071 |
| 27 | 2 41.696 | 2 51.526 | 3 1.355 | 3 11.185 | 3 21.014 | 3 30.844 | 3 40.674 | 3 50.503 | 27 | .074 |
| 28 | 2 41.860 | 2 51.690 | 3 1.519 | 3 11.349 | 3 21.178 | 3 31.008 | 3 40.837 | 3 50.667 | 28 | .076 |
| 29 | 2 42.024 | 2 51.853 | 3 1.683 | 3 11.513 | 3 21.342 | 3 31.172 | 3 41.001 | 3 50.831 | 29 | .079 |
| 30 | 2 42.188 | 2 52.017 | 3 1.847 | 3 11.676 | 3 21.506 | 3 31.336 | 3 41.165 | 3 50.995 | 30 | .082 |
| 31 | 2 42.352 | 2 52.181 | 3 2.011 | 3 11.840 | 3 21.670 | 3 31.499 | 3 41.329 | 3 51.158 | 31 | .085 |
| 32 | 2 42.515 | 2 52.345 | 3 2.174 | 3 12.004 | 3 21.834 | 3 31.663 | 3 41.493 | 3 51.322 | 32 | .087 |
| 33 | 2 42.679 | 2 52.509 | 3 2.338 | 3 12.168 | 3 21.997 | 3 31.827 | 3 41.657 | 3 51.486 | 33 | .090 |
| 34 | 2 42.843 | 2 52.673 | 3 2.502 | 3 12.332 | 3 22.161 | 3 31.991 | 3 41.820 | 3 51.650 | 34 | .093 |
| 35 | 2 43.007 | 2 52.836 | 3 2.666 | 3 12.496 | 3 22.325 | 3 32.155 | 3 41.984 | 3 51.814 | 35 | .096 |
| 36 | 2 43.171 | 2 53.000 | 3 2.830 | 3 12.659 | 3 22.489 | 3 32.318 | 3 42.148 | 3 51.978 | 36 | .098 |
| 37 | 2 43.334 | 2 53.164 | 3 2.994 | 3 12.823 | 3 22.653 | 3 32.482 | 3 42.312 | 3 52.141 | 37 | .101 |
| 38 | 2 43.498 | 2 53.328 | 3 3.157 | 3 12.987 | 3 22.817 | 3 32.646 | 3 42.476 | 3 52.305 | 38 | .104 |
| 39 | 2 43.662 | 2 53.492 | 3 3.321 | 3 13.151 | 3 22.980 | 3 32.810 | 3 42.639 | 3 52.469 | 39 | .106 |
| 40 | 2 43.826 | 2 53.656 | 3 3.485 | 3 13.315 | 3 23.144 | 3 32.974 | 3 42.803 | 3 52.633 | 40 | .109 |
| 41 | 2 43.990 | 2 53.819 | 3 3.649 | 3 13.478 | 3 23.308 | 3 33.138 | 3 42.967 | 3 52.797 | 41 | .112 |
| 42 | 2 44.154 | 2 53.983 | 3 3.813 | 3 13.642 | 3 23.472 | 3 33.301 | 3 43.131 | 3 52.961 | 42 | .115 |
| 43 | 2 44.317 | 2 54.147 | 3 3.977 | 3 13.806 | 3 23.636 | 3 33.465 | 3 43.295 | 3 53.124 | 43 | .117 |
| 44 | 2 44.481 | 2 54.311 | 3 4.140 | 3 13.970 | 3 23.800 | 3 33.629 | 3 43.459 | 3 53.288 | 44 | .120 |
| 45 | 2 44.645 | 2 54.475 | 3 4.304 | 3 14.134 | 3 23.963 | 3 33.793 | 3 43.622 | 3 53.452 | 45 | .123 |
| 46 | 2 44.809 | 2 54.638 | 3 4.468 | 3 14.298 | 3 24.127 | 3 33.957 | 3 43.786 | 3 53.616 | 46 | .126 |
| 47 | 2 44.973 | 2 54.802 | 3 4.632 | 3 14.461 | 3 24.291 | 3 34.121 | 3 43.950 | 3 53.780 | 47 | .128 |
| 48 | 2 45.137 | 2 54.966 | 3 4.796 | 3 14.625 | 3 24.455 | 3 34.284 | 3 44.114 | 3 53.943 | 48 | .131 |
| 49 | 2 45.300 | 2 55.130 | 3 4.960 | 3 14.789 | 3 24.619 | 3 34.448 | 3 44.278 | 3 54.107 | 49 | .134 |
| 50 | 2 45.464 | 2 55.294 | 3 5.123 | 3 14.953 | 3 24.782 | 3 34.612 | 3 44.442 | 3 54.271 | 50 | .137 |
| 51 | 2 45.628 | 2 55.458 | 3 5.287 | 3 15.117 | 3 24.946 | 3 34.776 | 3 44.605 | 3 54.435 | 51 | .139 |
| 52 | 2 45.792 | 2 55.621 | 3 5.451 | 3 15.281 | 3 25.110 | 3 34.940 | 3 44.769 | 3 54.599 | 52 | .142 |
| 53 | 2 45.956 | 2 55.785 | 3 5.615 | 3 15.444 | 3 25.274 | 3 35.104 | 3 44.933 | 3 54.763 | 53 | .145 |
| 54 | 2 46.120 | 2 55.949 | 3 5.779 | 3 15.608 | 3 25.438 | 3 35.267 | 3 45.097 | 3 54.926 | 54 | .147 |
| 55 | 2 46.283 | 2 56.113 | 3 5.942 | 3 15.772 | 3 25.602 | 3 35.431 | 3 45.261 | 3 55.090 | 55 | .150 |
| 56 | 2 46.447 | 2 56.277 | 3 6.106 | 3 15.936 | 3 25.765 | 3 35.595 | 3 45.425 | 3 55.254 | 56 | .153 |
| 57 | 2 46.611 | 2 56.441 | 3 6.270 | 3 16.100 | 3 25.929 | 3 35.759 | 3 45.588 | 3 55.418 | 57 | .156 |
| 58 | 2 46.755 | 2 56.604 | 3 6.434 | 3 16.264 | 3 26.093 | 3 35.923 | 3 45.752 | 3 55.582 | 58 | .158 |
| 59 | 2 46.939 | 2 56.768 | 3 6.598 | 3 16.427 | 3 26.257 | 3 36.086 | 3 45.916 | 3 55.746 | 59 | 0.161 |

# TABLE 9.

### Mean Solar into Sidereal Time.

To be added to a mean time interval.

| Mean. | 0h | 1h | 2h | 3h | 4h | 5h | 6h | 7h | For seconds. | |
|---|---|---|---|---|---|---|---|---|---|---|
| m. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | s. | s. |
| 0 | 0 0.000 | 0 9.856 | 0 19.713 | 0 29.569 | 0 39.426 | 0 49.282 | 0 59.139 | 1 8.995 | | |
| 1 | 0 0.164 | 0 10.021 | 0 19.877 | 0 29.734 | 0 39.590 | 0 49.447 | 0 59.303 | 1 9.160 | 1 | 0.003 |
| 2 | 0 0.329 | 0 10.185 | 0 20.041 | 0 29.898 | 0 39.754 | 0 49.611 | 0 59.467 | 1 9.324 | 2 | .005 |
| 3 | 0 0.493 | 0 10.349 | 0 20.206 | 0 30.062 | 0 39.919 | 0 49.775 | 0 59.632 | 1 9.488 | 3 | .008 |
| 4 | 0 0.657 | 0 10.514 | 0 20.370 | 0 30.227 | 0 40.083 | 0 49.939 | 0 59.796 | 1 9.652 | 4 | .011 |
| 5 | 0 0.821 | 0 10.678 | 0 20.534 | 0 30.391 | 0 40.247 | 0 50.104 | 0 59.960 | 1 9.817 | 5 | .014 |
| 6 | 0 0.986 | 0 10.842 | 0 20.699 | 0 30.555 | 0 40.412 | 0 50.268 | 1 0.124 | 1 9.981 | 6 | .016 |
| 7 | 0 1.150 | 0 11.006 | 0 20.863 | 0 30.719 | 0 40.576 | 0 50.432 | 1 0.289 | 1 10.145 | 7 | .019 |
| 8 | 0 1.314 | 0 11.171 | 0 21.027 | 0 30.884 | 0 40.740 | 0 50.597 | 1 0.453 | 1 10.310 | 8 | .022 |
| 9 | 0 1.478 | 0 11.335 | 0 21.191 | 0 31.048 | 0 40.904 | 0 50.761 | 1 0.617 | 1 10.474 | 9 | .025 |
| 10 | 0 1.643 | 0 11.499 | 0 21.356 | 0 31.212 | 0 41.069 | 0 50.925 | 1 0.782 | 1 10.638 | 10 | .027 |
| 11 | 0 1.807 | 0 11.663 | 0 21.520 | 0 31.376 | 0 41.233 | 0 51.089 | 1 0.946 | 1 10.802 | 11 | .030 |
| 12 | 0 1.971 | 0 11.828 | 0 21.684 | 0 31.541 | 0 41.397 | 0 51.254 | 1 1.110 | 1 10.967 | 12 | .033 |
| 13 | 0 2.136 | 0 11.992 | 0 21.849 | 0 31.705 | 0 41.561 | 0 51.418 | 1 1.274 | 1 11.131 | 13 | .036 |
| 14 | 0 2.300 | 0 12.156 | 0 22.013 | 0 31.869 | 0 41.726 | 0 51.582 | 1 1.439 | 1 11.295 | 14 | .038 |
| 15 | 0 2.464 | 0 12.321 | 0 22.177 | 0 32.034 | 0 41.890 | 0 51.746 | 1 1.603 | 1 11.459 | 15 | .041 |
| 16 | 0 2.628 | 0 12.485 | 0 22.341 | 0 32.198 | 0 42.054 | 0 51.911 | 1 1.767 | 1 11.624 | 16 | .044 |
| 17 | 0 2.793 | 0 12.649 | 0 22.506 | 0 32.362 | 0 42.219 | 0 52.075 | 1 1.932 | 1 11.788 | 17 | .047 |
| 18 | 0 2.957 | 0 12.813 | 0 22.670 | 0 32.526 | 0 42.383 | 0 52.239 | 1 2.096 | 1 11.952 | 18 | .049 |
| 19 | 0 3.121 | 0 12.978 | 0 22.834 | 0 32.691 | 0 42.547 | 0 52.404 | 1 2.260 | 1 12.117 | 19 | .052 |
| 20 | 0 3.285 | 0 13.142 | 0 22.998 | 0 32.855 | 0 42.711 | 0 52.568 | 1 2.424 | 1 12.281 | 20 | .055 |
| 21 | 0 3.450 | 0 13.306 | 0 23.163 | 0 33.019 | 0 42.876 | 0 52.732 | 1 2.589 | 1 12.445 | 21 | .057 |
| 22 | 0 3.614 | 0 13.471 | 0 23.327 | 0 33.183 | 0 43.040 | 0 52.896 | 1 2.753 | 1 12.609 | 22 | .060 |
| 23 | 0 3.778 | 0 13.635 | 0 23.491 | 0 33.348 | 0 43.204 | 0 53.061 | 1 2.917 | 1 12.774 | 23 | .063 |
| 24 | 0 3.943 | 0 13.799 | 0 23.656 | 0 33.512 | 0 43.368 | 0 53.225 | 1 3.081 | 1 12.938 | 24 | .066 |
| 25 | 0 4.107 | 0 13.963 | 0 23.820 | 0 33.676 | 0 43.533 | 0 53.389 | 1 3.246 | 1 13.102 | 25 | .068 |
| 26 | 0 4.271 | 0 14.128 | 0 23.984 | 0 33.841 | 0 43.697 | 0 53.554 | 1 3.410 | 1 13.266 | 26 | .071 |
| 27 | 0 4.435 | 0 14.292 | 0 24.148 | 0 34.005 | 0 43.861 | 0 53.718 | 1 3.574 | 1 13.431 | 27 | .074 |
| 28 | 0 4.600 | 0 14.456 | 0 24.313 | 0 34.169 | 0 44.026 | 0 53.882 | 1 3.739 | 1 13.595 | 28 | .077 |
| 29 | 0 4.764 | 0 14.620 | 0 24.477 | 0 34.333 | 0 44.190 | 0 54.046 | 1 3.903 | 1 13.759 | 29 | .079 |
| 30 | 0 4.928 | 0 14.785 | 0 24.641 | 0 34.498 | 0 44.354 | 0 54.211 | 1 4.067 | 1 13.924 | 30 | .082 |
| 31 | 0 5.093 | 0 14.949 | 0 24.805 | 0 34.662 | 0 44.518 | 0 54.375 | 1 4.231 | 1 14.088 | 31 | .085 |
| 32 | 0 5.257 | 0 15.113 | 0 24.970 | 0 34.826 | 0 44.683 | 0 54.539 | 1 4.396 | 1 14.252 | 32 | .088 |
| 33 | 0 5.421 | 0 15.278 | 0 25.134 | 0 34.990 | 0 44.847 | 0 54.703 | 1 4.560 | 1 14.416 | 33 | .090 |
| 34 | 0 5.585 | 0 15.442 | 0 25.298 | 0 35.155 | 0 45.011 | 0 54.868 | 1 4.724 | 1 14.581 | 34 | .093 |
| 35 | 0 5.750 | 0 15.606 | 0 25.463 | 0 35.319 | 0 45.176 | 0 55.032 | 1 4.888 | 1 14.745 | 35 | .096 |
| 36 | 0 5.914 | 0 15.770 | 0 25.627 | 0 35.483 | 0 45.340 | 0 55.196 | 1 5.053 | 1 14.909 | 36 | .099 |
| 37 | 0 6.078 | 0 15.935 | 0 25.791 | 0 35.648 | 0 45.504 | 0 55.361 | 1 5.217 | 1 15.073 | 37 | .101 |
| 38 | 0 6.242 | 0 16.099 | 0 25.955 | 0 35.812 | 0 45.668 | 0 55.525 | 1 5.381 | 1 15.238 | 38 | .104 |
| 39 | 0 6.407 | 0 16.263 | 0 26.120 | 0 35.976 | 0 45.833 | 0 55.689 | 1 5.546 | 1 15.402 | 39 | .107 |
| 40 | 0 6.571 | 0 16.427 | 0 26.284 | 0 36.140 | 0 45.997 | 0 55.853 | 1 5.710 | 1 15.566 | 40 | .110 |
| 41 | 0 6.735 | 0 16.592 | 0 26.448 | 0 36.305 | 0 46.161 | 0 56.018 | 1 5.874 | 1 15.731 | 41 | .112 |
| 42 | 0 6.900 | 0 16.756 | 0 26.612 | 0 36.469 | 0 46.325 | 0 56.182 | 1 6.038 | 1 15.895 | 42 | .115 |
| 43 | 0 7.064 | 0 16.920 | 0 26.777 | 0 36.633 | 0 46.490 | 0 56.346 | 1 6.203 | 1 16.059 | 43 | .118 |
| 44 | 0 7.228 | 0 17.085 | 0 26.941 | 0 36.798 | 0 46.654 | 0 56.510 | 1 6.367 | 1 16.223 | 44 | .120 |
| 45 | 0 7.392 | 0 17.249 | 0 27.105 | 0 36.962 | 0 46.818 | 0 56.675 | 1 6.531 | 1 16.388 | 45 | .123 |
| 46 | 0 7.557 | 0 17.413 | 0 27.270 | 0 37.126 | 0 46.983 | 0 56.839 | 1 6.695 | 1 16.552 | 46 | .126 |
| 47 | 0 7.721 | 0 17.577 | 0 27.434 | 0 37.290 | 0 47.147 | 0 57.003 | 1 6.860 | 1 16.716 | 47 | .129 |
| 48 | 0 7.885 | 0 17.742 | 0 27.598 | 0 37.455 | 0 47.311 | 0 57.168 | 1 7.024 | 1 16.881 | 48 | .131 |
| 49 | 0 8.049 | 0 17.906 | 0 27.762 | 0 37.619 | 0 47.475 | 0 57.332 | 1 7.188 | 1 17.045 | 49 | .134 |
| 50 | 0 8.214 | 0 18.070 | 0 27.927 | 0 37.783 | 0 47.640 | 0 57.496 | 1 7.353 | 1 17.209 | 50 | .137 |
| 51 | 0 8.378 | 0 18.234 | 0 28.091 | 0 37.947 | 0 47.804 | 0 57.660 | 1 7.517 | 1 17.373 | 51 | .140 |
| 52 | 0 8.542 | 0 18.399 | 0 28.255 | 0 38.112 | 0 47.968 | 0 57.825 | 1 7.681 | 1 17.538 | 52 | .142 |
| 53 | 0 8.707 | 0 18.563 | 0 28.420 | 0 38.276 | 0 48.132 | 0 57.989 | 1 7.845 | 1 17.702 | 53 | .145 |
| 54 | 0 8.871 | 0 18.727 | 0 28.584 | 0 38.440 | 0 48.297 | 0 58.153 | 1 8.010 | 1 17.866 | 54 | .148 |
| 55 | 0 9.035 | 0 18.892 | 0 28.748 | 0 38.605 | 0 48.461 | 0 58.317 | 1 8.174 | 1 18.030 | 55 | .151 |
| 56 | 0 9.199 | 0 19.056 | 0 28.912 | 0 38.769 | 0 48.625 | 0 58.482 | 1 8.338 | 1 18.195 | 56 | .153 |
| 57 | 0 9.364 | 0 19.220 | 0 29.077 | 0 38.933 | 0 48.790 | 0 58.646 | 1 8.502 | 1 18.359 | 57 | .156 |
| 58 | 0 9.528 | 0 19.384 | 0 29.241 | 0 39.097 | 0 48.954 | 0 58.810 | 1 8.667 | 1 18.523 | 58 | .159 |
| 59 | 0 9.692 | 0 19.549 | 0 29.405 | 0 39.262 | 0 49.118 | 0 58.975 | 1 8.831 | 1 18.688 | 59 | 0.162 |

TABLE 9. [Page 483

## Mean Solar into Sidereal Time.

To be added to a mean time interval.

| Mean. | 8h | 9h | 10h | 11h | 12h | 13h | 14h | 15h | For seconds. | |
|---|---|---|---|---|---|---|---|---|---|---|
| m. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | s. | s. |
| 0 | 1 18.852 | 1 28.708 | 1 38.565 | 1 48.421 | 1 58.278 | 2 8.134 | 2 17.991 | 2 27.847 | | |
| 1 | 1 19.016 | 1 28.873 | 1 38.729 | 1 48.585 | 1 58.442 | 2 8.298 | 2 18.155 | 2 28.011 | 1 | 0.003 |
| 2 | 1 19.180 | 1 29.037 | 1 38.893 | 1 48.750 | 1 58.606 | 2 8.463 | 2 18.319 | 2 28.176 | 2 | .005 |
| 3 | 1 19.345 | 1 29.201 | 1 39.058 | 1 48.914 | 1 58.771 | 2 8.627 | 2 18.483 | 2 28.340 | 3 | .008 |
| 4 | 1 19.509 | 1 29.365 | 1 39.222 | 1 49.078 | 1 58.935 | 2 8.791 | 2 18.648 | 2 28.504 | 4 | .011 |
| 5 | 1 19.673 | 1 29.530 | 1 39.386 | 1 49.243 | 1 59.099 | 2 8.956 | 2 18.812 | 2 28.668 | 5 | .014 |
| 6 | 1 19.837 | 1 29.694 | 1 39.550 | 1 49.407 | 1 59.263 | 2 9.120 | 2 18.976 | 2 28.833 | 6 | .016 |
| 7 | 1 20.002 | 1 29.858 | 1 39.715 | 1 49.571 | 1 59.428 | 2 9.284 | 2 19.141 | 2 28.997 | 7 | .019 |
| 8 | 1 20.166 | 1 30.022 | 1 39.879 | 1 49.735 | 1 59.592 | 2 9.448 | 2 19.305 | 2 29.161 | 8 | .022 |
| 9 | 1 20.330 | 1 30.187 | 1 40.043 | 1 49.900 | 1 59.756 | 2 9.613 | 2 19.469 | 2 29.326 | 9 | .025 |
| 10 | 1 20.495 | 1 30.351 | 1 40.207 | 1 50.064 | 1 59.920 | 2 9.777 | 2 19.633 | 2 29.490 | 10 | .027 |
| 11 | 1 20.659 | 1 30.515 | 1 40.372 | 1 50.228 | 2 0.085 | 2 9.941 | 2 19.798 | 2 29.654 | 11 | .030 |
| 12 | 1 20.823 | 1 30.680 | 1 40.536 | 1 50.393 | 2 0.249 | 2 10.105 | 2 19.962 | 2 29.818 | 12 | .033 |
| 13 | 1 20.987 | 1 30.844 | 1 40.700 | 1 50.557 | 2 0.413 | 2 10.270 | 2 20.126 | 2 29.983 | 13 | .036 |
| 14 | 1 21.152 | 1 31.008 | 1 40.865 | 1 50.721 | 2 0.578 | 2 10.434 | 2 20.290 | 2 30.147 | 14 | .038 |
| 15 | 1 21.316 | 1 31.172 | 1 41.029 | 1 50.885 | 2 0.742 | 2 10.598 | 2 20.455 | 2 30.311 | 15 | .041 |
| 16 | 1 21.480 | 1 31.337 | 1 41.193 | 1 51.050 | 2 0.906 | 2 10.763 | 2 20.619 | 2 30.476 | 16 | .044 |
| 17 | 1 21.644 | 1 31.501 | 1 41.357 | 1 51.214 | 2 1.070 | 2 10.927 | 2 20.783 | 2 30.640 | 17 | .047 |
| 18 | 1 21.809 | 1 31.665 | 1 41.522 | 1 51.378 | 2 1.235 | 2 11.091 | 2 20.948 | 2 30.804 | 18 | .049 |
| 19 | 1 21.973 | 1 31.829 | 1 41.686 | 1 51.542 | 2 1.399 | 2 11.255 | 2 21.112 | 2 30.968 | 19 | .052 |
| 20 | 1 22.137 | 1 31.994 | 1 41.850 | 1 51.707 | 2 1.563 | 2 11.420 | 2 21.276 | 2 31.133 | 20 | .055 |
| 21 | 1 22.302 | 1 32.158 | 1 42.015 | 1 51.871 | 2 1.727 | 2 11.584 | 2 21.440 | 2 31.297 | 21 | .057 |
| 22 | 1 22.466 | 1 32.322 | 1 42.179 | 1 52.035 | 2 1.892 | 2 11.748 | 2 21.605 | 2 31.461 | 22 | .060 |
| 23 | 1 22.630 | 1 32.487 | 1 42.343 | 1 52.200 | 2 2.056 | 2 11.912 | 2 21.769 | 2 31.625 | 23 | .063 |
| 24 | 1 22.794 | 1 32.651 | 1 42.507 | 1 52.364 | 2 2.220 | 2 12.077 | 2 21.933 | 2 31.790 | 24 | .066 |
| 25 | 1 22.959 | 1 32.815 | 1 42.672 | 1 52.528 | 2 2.385 | 2 12.241 | 2 22.098 | 2 31.954 | 25 | .068 |
| 26 | 1 23.123 | 1 32.979 | 1 42.836 | 1 52.692 | 2 2.549 | 2 12.405 | 2 22.262 | 2 32.118 | 26 | .071 |
| 27 | 1 23.287 | 1 33.144 | 1 43.000 | 1 52.857 | 2 2.713 | 2 12.570 | 2 22.426 | 2 32.283 | 27 | .074 |
| 28 | 1 23.451 | 1 33.308 | 1 43.164 | 1 53.021 | 2 2.877 | 2 12.734 | 2 22.590 | 2 32.447 | 28 | .077 |
| 29 | 1 23.616 | 1 33.472 | 1 43.329 | 1 53.185 | 2 3.042 | 2 12.898 | 2 22.755 | 2 32.611 | 29 | .079 |
| 30 | 1 23.780 | 1 33.637 | 1 43.493 | 1 53.349 | 2 3.206 | 2 13.062 | 2 22.919 | 2 32.775 | 30 | .082 |
| 31 | 1 23.944 | 1 33.801 | 1 43.657 | 1 53.514 | 2 3.370 | 2 13.227 | 2 23.083 | 2 32.940 | 31 | .085 |
| 32 | 1 24.109 | 1 33.965 | 1 43.822 | 1 53.678 | 2 3.534 | 2 13.391 | 2 23.247 | 2 33.104 | 32 | .088 |
| 33 | 1 24.273 | 1 34.129 | 1 43.986 | 1 53.842 | 2 3.699 | 2 13.555 | 2 23.412 | 2 33.268 | 33 | .090 |
| 34 | 1 24.437 | 1 34.294 | 1 44.150 | 1 54.007 | 2 3.863 | 2 13.720 | 2 23.576 | 2 33.432 | 34 | .093 |
| 35 | 1 24.601 | 1 34.458 | 1 44.314 | 1 54.171 | 2 4.027 | 2 13.884 | 2 23.740 | 2 33.597 | 35 | .096 |
| 36 | 1 24.766 | 1 34.622 | 1 44.479 | 1 54.335 | 2 4.192 | 2 14.048 | 2 23.905 | 2 33.761 | 36 | .099 |
| 37 | 1 24.930 | 1 34.786 | 1 44.643 | 1 54.499 | 2 4.356 | 2 14.212 | 2 24.069 | 2 33.925 | 37 | .101 |
| 38 | 1 25.094 | 1 34.951 | 1 44.807 | 1 54.664 | 2 4.520 | 2 14.377 | 2 24.233 | 2 34.090 | 38 | .104 |
| 39 | 1 25.259 | 1 35.115 | 1 44.971 | 1 54.828 | 2 4.684 | 2 14.541 | 2 24.397 | 2 34.254 | 39 | .107 |
| 40 | 1 25.423 | 1 35.279 | 1 45.136 | 1 54.992 | 2 4.849 | 2 14.705 | 2 24.562 | 2 34.418 | 40 | .110 |
| 41 | 1 25.587 | 1 35.444 | 1 45.300 | 1 55.156 | 2 5.013 | 2 14.869 | 2 24.726 | 2 34.582 | 41 | .112 |
| 42 | 1 25.751 | 1 35.608 | 1 45.464 | 1 55.321 | 2 5.177 | 2 15.034 | 2 24.890 | 2 34.747 | 42 | .115 |
| 43 | 1 25.916 | 1 35.772 | 1 45.629 | 1 55.485 | 2 5.342 | 2 15.198 | 2 25.054 | 2 34.911 | 43 | .118 |
| 44 | 1 26.080 | 1 35.936 | 1 45.793 | 1 55.649 | 2 5.506 | 2 15.362 | 2 25.219 | 2 35.075 | 44 | .120 |
| 45 | 1 26.244 | 1 36.101 | 1 45.957 | 1 55.814 | 2 5.670 | 2 15.527 | 2 25.383 | 2 35.239 | 45 | .123 |
| 46 | 1 26.408 | 1 36.265 | 1 46.121 | 1 55.978 | 2 5.834 | 2 15.691 | 2 25.547 | 2 35.404 | 46 | .126 |
| 47 | 1 26.573 | 1 36.429 | 1 46.286 | 1 56.142 | 2 5.999 | 2 15.855 | 2 25.712 | 2 35.568 | 47 | .129 |
| 48 | 1 26.737 | 1 36.593 | 1 46.450 | 1 56.306 | 2 6.163 | 2 16.019 | 2 25.876 | 2 35.732 | 48 | .131 |
| 49 | 1 26.901 | 1 36.758 | 1 46.614 | 1 56.471 | 2 6.327 | 2 16.184 | 2 26.040 | 2 35.897 | 49 | .134 |
| 50 | 1 27.066 | 1 36.922 | 1 46.778 | 1 56.635 | 2 6.491 | 2 16.348 | 2 26.204 | 2 36.061 | 50 | .137 |
| 51 | 1 27.230 | 1 37.086 | 1 46.943 | 1 56.799 | 2 6.656 | 2 16.512 | 2 26.369 | 2 36.225 | 51 | .140 |
| 52 | 1 27.394 | 1 37.251 | 1 47.107 | 1 56.964 | 2 6.820 | 2 16.676 | 2 26.533 | 2 36.389 | 52 | .142 |
| 53 | 1 27.558 | 1 37.415 | 1 47.271 | 1 57.128 | 2 6.984 | 2 16.841 | 2 26.697 | 2 36.554 | 53 | .145 |
| 54 | 1 27.723 | 1 37.579 | 1 47.436 | 1 57.292 | 2 7.149 | 2 17.005 | 2 26.861 | 2 36.718 | 54 | .148 |
| 55 | 1 27.887 | 1 37.743 | 1 47.600 | 1 57.456 | 2 7.313 | 2 17.169 | 2 27.026 | 2 36.882 | 55 | .151 |
| 56 | 1 28.051 | 1 37.908 | 1 47.764 | 1 57.621 | 2 7.477 | 2 17.334 | 2 27.190 | 2 37.047 | 56 | .153 |
| 57 | 1 28.215 | 1 38.072 | 1 47.928 | 1 57.785 | 2 7.641 | 2 17.498 | 2 27.354 | 2 37.211 | 57 | .156 |
| 58 | 1 28.380 | 1 38.236 | 1 48.093 | 1 57.949 | 2 7.806 | 2 17.662 | 2 27.519 | 2 37.375 | 58 | .159 |
| 59 | 1 28.544 | 1 38.400 | 1 48.257 | 1 58.113 | 2 7.970 | 2 17.826 | 2 27.683 | 2 37.539 | 59 | 0.162 |

# TABLE 9.

## Mean Solar into Sidereal time.

To be added to a mean time interval.

| Mean. | 16ʰ | 17ʰ | 18ʰ | 19ʰ | 20ʰ | 21ʰ | 22ʰ | 23ʰ | For seconds. | |
|---|---|---|---|---|---|---|---|---|---|---|
| *m.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *m. s.* | *s.* | *s.* |
| 0 | 2 37.704 | 2 47.560 | 2 57.417 | 3 7.273 | 3 17.129 | 3 26.986 | 3 36.842 | 3 46.699 | | |
| 1 | 2 37.868 | 2 47.724 | 2 57.581 | 3 7.437 | 3 17.294 | 3 27.150 | 3 37.007 | 3 46.863 | 1 | 0.003 |
| 2 | 2 38.032 | 2 47.889 | 2 57.745 | 3 7.602 | 3 17.458 | 3 27.315 | 3 37.171 | 3 47.027 | 2 | .005 |
| 3 | 2 38.196 | 2 48.053 | 2 57.909 | 3 7.766 | 3 17.622 | 3 27.479 | 3 37.335 | 3 47.192 | 3 | .008 |
| 4 | 2 38.361 | 2 48.217 | 2 58.074 | 3 7.930 | 3 17.787 | 3 27.643 | 3 37.500 | 3 47.356 | 4 | .011 |
| 5 | 2 38.525 | 2 48.381 | 2 58.238 | 3 8.094 | 3 17.951 | 3 27.807 | 3 37.664 | 3 47.520 | 5 | .014 |
| 6 | 2 38.689 | 2 48.546 | 2 58.402 | 3 8.259 | 3 18.115 | 3 27.972 | 3 37.828 | 3 47.685 | 6 | .016 |
| 7 | 2 38.854 | 2 48.710 | 2 58.566 | 3 8.423 | 3 18.279 | 3 28.136 | 3 37.992 | 3 47.849 | 7 | .019 |
| 8 | 2 39.018 | 2 48.874 | 2 58.731 | 3 8.587 | 3 18.444 | 3 28.300 | 3 38.157 | 3 48.013 | 8 | .022 |
| 9 | 2 39.182 | 2 49.039 | 2 58.895 | 3 8.751 | 3 18.608 | 3 28.464 | 3 38.321 | 3 48.177 | 9 | .025 |
| 10 | 2 39.346 | 2 49.203 | 2 59.059 | 3 8.916 | 3 18.772 | 3 28.629 | 3 38.485 | 3 48.342 | 10 | .027 |
| 11 | 2 39.511 | 2 49.367 | 2 59.224 | 3 9.080 | 3 18.937 | 3 28.793 | 3 38.649 | 3 48.506 | 11 | .030 |
| 12 | 2 39.675 | 2 49.531 | 2 59.388 | 3 9.244 | 3 19.101 | 3 28.957 | 3 38.814 | 3 48.670 | 12 | .033 |
| 13 | 2 39.839 | 2 49.696 | 2 59.552 | 3 9.409 | 3 19.265 | 3 29.122 | 3 38.978 | 3 48.834 | 13 | .036 |
| 14 | 2 40.003 | 2 49.860 | 2 59.716 | 3 9.573 | 3 19.429 | 3 29.286 | 3 39.142 | 3 48.999 | 14 | .038 |
| 15 | 2 40.168 | 2 50.024 | 2 59.881 | 3 9.737 | 3 19.594 | 3 29.450 | 3 39.307 | 3 49.163 | 15 | .041 |
| 16 | 2 40.332 | 2 50.188 | 3 0.045 | 3 9.901 | 3 19.758 | 3 29.614 | 3 39.471 | 3 49.327 | 16 | .044 |
| 17 | 2 40.496 | 2 50.353 | 3 0.209 | 3 10.066 | 3 19.922 | 3 29.779 | 3 39.635 | 3 49.492 | 17 | .047 |
| 18 | 2 40.661 | 2 50.517 | 3 0.373 | 3 10.230 | 3 20.086 | 3 29.943 | 3 39.799 | 3 49.656 | 18 | .049 |
| 19 | 2 40.825 | 2 50.681 | 3 0.538 | 3 10.394 | 3 20.251 | 3 30.107 | 3 39.964 | 3 49.820 | 19 | .052 |
| 20 | 2 40.989 | 2 50.846 | 3 0.702 | 3 10.559 | 3 20.415 | 3 30.271 | 3 40.128 | 3 49.984 | 20 | .055 |
| 21 | 2 41.153 | 2 51.010 | 3 0.866 | 3 10.723 | 3 20.579 | 3 30.436 | 3 40.292 | 3 50.149 | 21 | .057 |
| 22 | 2 41.318 | 2 51.174 | 3 1.031 | 3 10.887 | 3 20.744 | 3 30.600 | 3 40.456 | 3 50.313 | 22 | .060 |
| 23 | 2 41.482 | 2 51.338 | 3 1.195 | 3 11.051 | 3 20.908 | 3 30.764 | 3 40.621 | 3 50.477 | 23 | .063 |
| 24 | 2 41.646 | 2 51.503 | 3 1.359 | 3 11.216 | 3 21.072 | 3 30.929 | 3 40.785 | 3 50.642 | 24 | .066 |
| 25 | 2 41.810 | 2 51.667 | 3 1.523 | 3 11.380 | 3 21.236 | 3 31.093 | 3 40.949 | 3 50.806 | 25 | .068 |
| 26 | 2 41.975 | 2 51.831 | 3 1.688 | 3 11.544 | 3 21.401 | 3 31.257 | 3 41.114 | 3 50.970 | 26 | .071 |
| 27 | 2 42.139 | 2 51.995 | 3 1.852 | 3 11.708 | 3 21.565 | 3 31.421 | 3 41.278 | 3 51.134 | 27 | .074 |
| 28 | 2 42.303 | 2 52.160 | 3 2.016 | 3 11.873 | 3 21.729 | 3 31.586 | 3 41.442 | 3 51.299 | 28 | .077 |
| 29 | 2 42.468 | 2 52.324 | 3 2.181 | 3 12.037 | 3 21.893 | 3 31.750 | 3 41.606 | 3 51.463 | 29 | .079 |
| 30 | 2 42.632 | 2 52.488 | 3 2.345 | 3 12.201 | 3 22.058 | 3 31.914 | 3 41.771 | 3 51.627 | 30 | .082 |
| 31 | 2 42.796 | 2 52.653 | 3 2.509 | 3 12.366 | 3 22.222 | 3 32.078 | 3 41.935 | 3 51.791 | 31 | .085 |
| 32 | 2 42.960 | 2 52.817 | 3 2.673 | 3 12.530 | 3 22.386 | 3 32.243 | 3 42.099 | 3 51.956 | 32 | .088 |
| 33 | 2 43.125 | 2 52.981 | 3 2.838 | 3 12.694 | 3 22.551 | 3 32.407 | 3 42.264 | 3 52.120 | 33 | .090 |
| 34 | 2 43.289 | 2 53.145 | 3 3.002 | 3 12.858 | 3 22.715 | 3 32.571 | 3 42.428 | 3 52.284 | 34 | .093 |
| 35 | 2 43.453 | 2 53.310 | 3 3.166 | 3 13.023 | 3 22.879 | 3 32.736 | 3 42.592 | 3 52.449 | 35 | .096 |
| 36 | 2 43.617 | 2 53.474 | 3 3.330 | 3 13.187 | 3 23.043 | 3 32.900 | 3 42.756 | 3 52.613 | 36 | .099 |
| 37 | 2 43.782 | 2 53.638 | 3 3.495 | 3 13.351 | 3 23.208 | 3 33.064 | 3 42.921 | 3 52.777 | 37 | .101 |
| 38 | 2 43.946 | 2 53.803 | 3 3.659 | 3 13.515 | 3 23.372 | 3 33.228 | 3 43.085 | 3 52.941 | 38 | .104 |
| 39 | 2 44.110 | 2 53.967 | 3 3.823 | 3 13.680 | 3 23.536 | 3 33.393 | 3 43.249 | 3 53.106 | 39 | .107 |
| 40 | 2 44.275 | 2 54.131 | 3 3.988 | 3 13.844 | 3 23.700 | 3 33.557 | 3 43.413 | 3 53.270 | 40 | .110 |
| 41 | 2 44.439 | 2 54.295 | 3 4.152 | 3 14.008 | 3 23.865 | 3 33.721 | 3 43.578 | 3 53.434 | 41 | .112 |
| 42 | 2 44.603 | 2 54.460 | 3 4.316 | 3 14.173 | 3 24.029 | 3 33.886 | 3 43.742 | 3 53.598 | 42 | .115 |
| 43 | 2 44.767 | 2 54.624 | 3 4.480 | 3 14.337 | 3 24.193 | 3 34.050 | 3 43.906 | 3 53.763 | 43 | .118 |
| 44 | 2 44.932 | 2 54.788 | 3 4.645 | 3 14.501 | 3 24.358 | 3 34.214 | 3 44.071 | 3 53.927 | 44 | .120 |
| 45 | 2 45.096 | 2 54.952 | 3 4.809 | 3 14.665 | 3 24.522 | 3 34.378 | 3 44.235 | 3 54.091 | 45 | .123 |
| 46 | 2 45.260 | 2 55.117 | 3 4.973 | 3 14.830 | 3 24.686 | 3 34.543 | 3 44.399 | 3 54.256 | 46 | .126 |
| 47 | 2 45.425 | 2 55.281 | 3 5.137 | 3 14.994 | 3 24.850 | 3 34.707 | 3 44.563 | 3 54.420 | 47 | .129 |
| 48 | 2 45.589 | 2 55.445 | 3 5.302 | 3 15.158 | 3 25.015 | 3 34.871 | 3 44.728 | 3 54.584 | 48 | .131 |
| 49 | 2 45.753 | 2 55.610 | 3 5.466 | 3 15.322 | 3 25.179 | 3 35.035 | 3 44.892 | 3 54.748 | 49 | .134 |
| 50 | 2 45.917 | 2 55.774 | 3 5.630 | 3 15.487 | 3 25.343 | 3 35.200 | 3 45.056 | 3 54.913 | 50 | .137 |
| 51 | 2 46.082 | 2 55.938 | 3 5.795 | 3 15.651 | 3 25.508 | 3 35.364 | 3 45.220 | 3 55.077 | 51 | .140 |
| 52 | 2 46.246 | 2 56.102 | 3 5.959 | 3 15.815 | 3 25.672 | 3 35.528 | 3 45.385 | 3 55.241 | 52 | .142 |
| 53 | 2 46.410 | 2 56.267 | 3 6.123 | 3 15.980 | 3 25.836 | 3 35.693 | 3 45.549 | 3 55.405 | 53 | .145 |
| 54 | 2 46.574 | 2 56.431 | 3 6.287 | 3 16.144 | 3 26.000 | 3 35.857 | 3 45.713 | 3 55.570 | 54 | .148 |
| 55 | 2 46.739 | 2 56.595 | 3 6.452 | 3 16.308 | 3 26.165 | 3 36.021 | 3 45.878 | 3 55.734 | 55 | .151 |
| 56 | 2 46.903 | 2 56.759 | 3 6.616 | 3 16.472 | 3 26.329 | 3 36.185 | 3 46.042 | 3 55.898 | 56 | .153 |
| 57 | 2 47.067 | 2 56.924 | 3 6.780 | 3 16.637 | 3 26.493 | 3 36.350 | 3 46.206 | 3 56.063 | 57 | .156 |
| 58 | 2 47.232 | 2 57.088 | 3 6.944 | 3 16.801 | 3 26.657 | 3 36.514 | 3 46.370 | 3 56.227 | 58 | .159 |
| 59 | 2 47.396 | 2 57.252 | 3 7.109 | 3 16.965 | 3 26.822 | 3 36.678 | 3 46.535 | 3 56.391 | 59 | 0.162 |

TABLE 10. [Page 485

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°—March 21 to June 22.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

### North Latitude: 21° to 40°—March 21 to June 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

| Lat. N. | Approx. date. | MARCH. | | | | | APRIL. | | | | | | | | | | MAY. | | | | | | | JUNE. | | | Approx. date. | Lat. N. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 21 | 23 | 26 | 28 | 31 | 3 | 5 | 8 | 11 | 13 | 16 | 19 | 22 | 25 | 28 | 1 | 5 | 8 | 12 | 16 | 21 | 26 | 1 | 10 | 22 | | |
| | Dec. N. | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 23° 27′ | Dec. N. | |
| ° | | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | | ° |
| 21 | R. | 6 03 | 6 01 | 5 59 | 5 57 | 5 54 | 5 52 | 5 50 | 5 48 | 5 45 | 5 43 | 5 40 | 5 38 | 5 36 | 5 33 | 5 31 | 5 30 | 5 28 | 5 25 | 5 23 | 5 22 | 5 20 | 5 19 | 5 18 | 5 17 | 5 18 | R. | 21 |
| | S. | 6 11 | 6 12 | 6 13 | 6 14 | 6 14 | 6 15 | 6 16 | 6 17 | 6 18 | 6 19 | 6 20 | 6 21 | 6 22 | 6 22 | 6 23 | 6 25 | 6 26 | 6 27 | 6 29 | 6 31 | 6 33 | 6 35 | 6 38 | 6 41 | 6 44 | S. | |
| 22 | R. | 6 03 | 6 01 | 5 59 | 5 57 | 5 54 | 5 52 | 5 49 | 5 47 | 5 44 | 5 42 | 5 40 | 5 37 | 5 35 | 5 32 | 5 30 | 5 28 | 5 26 | 5 24 | 5 22 | 5 20 | 5 18 | 5 17 | 5 16 | 5 15 | 5 16 | R. | 22 |
| | S. | 6 11 | 6 12 | 6 13 | 6 14 | 6 14 | 6 15 | 6 16 | 6 17 | 6 18 | 6 19 | 6 20 | 6 21 | 6 23 | 6 23 | 6 24 | 6 26 | 6 27 | 6 29 | 6 31 | 6 32 | 6 34 | 6 37 | 6 40 | 6 43 | 6 46 | S. | |
| 23 | R. | 6 03 | 6 01 | 5 59 | 5 56 | 5 54 | 5 52 | 5 49 | 5 47 | 5 44 | 5 42 | 5 39 | 5 36 | 5 34 | 5 31 | 5 29 | 5 27 | 5 25 | 5 22 | 5 20 | 5 18 | 5 16 | 5 15 | 5 14 | 5 13 | 5 14 | R. | 23 |
| | S. | 6 11 | 6 12 | 6 13 | 6 14 | 6 15 | 6 16 | 6 17 | 6 18 | 6 19 | 6 20 | 6 21 | 6 22 | 6 24 | 6 25 | 6 26 | 6 27 | 6 29 | 6 30 | 6 32 | 6 34 | 6 36 | 6 39 | 6 42 | 6 45 | 6 48 | S. | |
| 24 | R. | 6 03 | 6 01 | 5 59 | 5 56 | 5 53 | 5 51 | 5 48 | 5 46 | 5 43 | 5 41 | 5 38 | 5 35 | 5 33 | 5 30 | 5 28 | 5 26 | 5 23 | 5 21 | 5 19 | 5 17 | 5 15 | 5 13 | 5 12 | 5 11 | 5 12 | R. | 24 |
| | S. | 6 11 | 6 12 | 6 13 | 6 14 | 6 15 | 6 16 | 6 17 | 6 18 | 6 19 | 6 21 | 6 22 | 6 23 | 6 25 | 6 26 | 6 27 | 6 29 | 6 30 | 6 32 | 6 34 | 6 36 | 6 38 | 6 40 | 6 44 | 6 47 | 6 50 | S. | |
| 25 | R. | 6 03 | 6 01 | 5 58 | 5 56 | 5 53 | 5 51 | 5 48 | 5 45 | 5 42 | 5 40 | 5 37 | 5 34 | 5 32 | 5 29 | 5 26 | 5 24 | 5 22 | 5 19 | 5 17 | 5 15 | 5 13 | 5 11 | 5 10 | 5 09 | 5 10 | R. | 25 |
| | S. | 6 11 | 6 12 | 6 13 | 6 15 | 6 16 | 6 17 | 6 18 | 6 19 | 6 20 | 6 22 | 6 23 | 6 24 | 6 26 | 6 27 | 6 28 | 6 30 | 6 32 | 6 33 | 6 36 | 6 38 | 6 40 | 6 42 | 6 46 | 6 50 | 6 53 | S. | |
| 26 | R. | 6 03 | 6 01 | 5 58 | 5 56 | 5 53 | 5 50 | 5 47 | 5 45 | 5 42 | 5 39 | 5 36 | 5 33 | 5 31 | 5 28 | 5 25 | 5 23 | 5 20 | 5 18 | 5 15 | 5 13 | 5 11 | 5 09 | 5 08 | 5 07 | 5 08 | R. | 26 |
| | S. | 6 11 | 6 12 | 6 13 | 6 15 | 6 16 | 6 17 | 6 18 | 6 20 | 6 21 | 6 22 | 6 24 | 6 25 | 6 27 | 6 28 | 6 29 | 6 31 | 6 33 | 6 35 | 6 37 | 6 39 | 6 41 | 6 44 | 6 48 | 6 52 | 6 55 | S. | |
| 27 | R. | 6 03 | 6 01 | 5 58 | 5 55 | 5 52 | 5 50 | 5 47 | 5 44 | 5 41 | 5 38 | 5 35 | 5 32 | 5 30 | 5 27 | 5 24 | 5 22 | 5 19 | 5 16 | 5 14 | 5 12 | 5 09 | 5 07 | 5 06 | 5 05 | 5 06 | R. | 27 |
| | S. | 6 11 | 6 13 | 6 14 | 6 15 | 6 16 | 6 18 | 6 19 | 6 20 | 6 22 | 6 23 | 6 25 | 6 26 | 6 28 | 6 29 | 6 31 | 6 33 | 6 35 | 6 36 | 6 39 | 6 41 | 6 43 | 6 46 | 6 50 | 6 54 | 6 58 | S. | |
| 28 | R. | 6 03 | 6 01 | 5 58 | 5 55 | 5 52 | 5 49 | 5 46 | 5 43 | 5 40 | 5 37 | 5 34 | 5 31 | 5 29 | 5 26 | 5 22 | 5 20 | 5 17 | 5 15 | 5 12 | 5 10 | 5 07 | 5 05 | 5 04 | 5 03 | 5 04 | R. | 28 |
| | S. | 6 11 | 6 13 | 6 14 | 6 15 | 6 17 | 6 18 | 6 19 | 6 21 | 6 23 | 6 24 | 6 26 | 6 27 | 6 29 | 6 30 | 6 32 | 6 34 | 6 36 | 6 38 | 6 40 | 6 43 | 6 45 | 6 48 | 6 52 | 6 56 | 7 00 | S. | |
| 29 | R. | 6 03 | 6 01 | 5 57 | 5 55 | 5 52 | 5 49 | 5 45 | 5 42 | 5 39 | 5 36 | 5 33 | 5 30 | 5 27 | 5 24 | 5 21 | 5 19 | 5 16 | 5 13 | 5 10 | 5 08 | 5 05 | 5 03 | 5 01 | 5 00 | 5 01 | R. | 29 |
| | S. | 6 11 | 6 13 | 6 14 | 6 16 | 6 17 | 6 19 | 6 20 | 6 22 | 6 24 | 6 25 | 6 27 | 6 28 | 6 30 | 6 32 | 6 34 | 6 36 | 6 38 | 6 40 | 6 42 | 6 45 | 6 47 | 6 50 | 6 54 | 6 58 | 7 02 | S. | |
| 30 | R. | 6 03 | 6 00 | 5 57 | 5 54 | 5 51 | 5 48 | 5 45 | 5 42 | 5 38 | 5 35 | 5 32 | 5 29 | 5 26 | 5 23 | 5 20 | 5 17 | 5 14 | 5 11 | 5 09 | 5 06 | 5 03 | 5 01 | 4 59 | 4 58 | 4 59 | R. | 30 |
| | S. | 6 12 | 6 13 | 6 14 | 6 16 | 6 17 | 6 19 | 6 21 | 6 23 | 6 24 | 6 26 | 6 28 | 6 29 | 6 31 | 6 33 | 6 35 | 6 37 | 6 39 | 6 41 | 6 44 | 6 46 | 6 49 | 6 52 | 6 56 | 7 01 | 7 05 | S. | |
| 31 | R. | 6 03 | 6 00 | 5 57 | 5 54 | 5 51 | 5 48 | 5 44 | 5 41 | 5 37 | 5 34 | 5 31 | 5 28 | 5 25 | 5 22 | 5 18 | 5 16 | 5 13 | 5 10 | 5 07 | 5 04 | 5 01 | 4 59 | 4 57 | 4 55 | 4 56 | R. | 31 |
| | S. | 6 12 | 6 13 | 6 15 | 6 17 | 6 18 | 6 20 | 6 21 | 6 23 | 6 25 | 6 27 | 6 29 | 6 31 | 6 33 | 6 35 | 6 37 | 6 39 | 6 41 | 6 43 | 6 46 | 6 48 | 6 51 | 6 55 | 6 59 | 7 03 | 7 07 | S. | |
| 32 | R. | 6 03 | 6 00 | 5 56 | 5 53 | 5 50 | 5 47 | 5 44 | 5 41 | 5 37 | 5 34 | 5 30 | 5 27 | 5 24 | 5 21 | 5 17 | 5 14 | 5 11 | 5 08 | 5 05 | 5 02 | 4 59 | 4 56 | 4 54 | 4 53 | 4 54 | R. | 32 |
| | S. | 6 12 | 6 14 | 6 15 | 6 17 | 6 18 | 6 20 | 6 22 | 6 24 | 6 26 | 6 28 | 6 30 | 6 32 | 6 34 | 6 36 | 6 38 | 6 40 | 6 42 | 6 45 | 6 48 | 6 50 | 6 53 | 6 57 | 7 01 | 7 06 | 7 10 | S. | |
| 33 | R. | 6 03 | 6 00 | 5 56 | 5 53 | 5 50 | 5 47 | 5 43 | 5 40 | 5 36 | 5 33 | 5 29 | 5 26 | 5 22 | 5 19 | 5 15 | 5 12 | 5 09 | 5 06 | 5 03 | 5 00 | 4 57 | 4 54 | 4 52 | 4 50 | 4 51 | R. | 33 |
| | S. | 6 12 | 6 14 | 6 15 | 6 17 | 6 19 | 6 21 | 6 23 | 6 25 | 6 27 | 6 29 | 6 31 | 6 33 | 6 35 | 6 37 | 6 39 | 6 42 | 6 44 | 6 47 | 6 50 | 6 53 | 6 56 | 6 59 | 7 04 | 7 08 | 7 12 | S. | |
| 34 | R. | 6 03 | 6 00 | 5 56 | 5 53 | 5 49 | 5 46 | 5 42 | 5 39 | 5 35 | 5 32 | 5 28 | 5 25 | 5 21 | 5 18 | 5 14 | 5 11 | 5 08 | 5 04 | 5 01 | 4 58 | 4 55 | 4 52 | 4 50 | 4 48 | 4 49 | R. | 34 |
| | S. | 6 12 | 6 14 | 6 16 | 6 18 | 6 19 | 6 21 | 6 23 | 6 25 | 6 27 | 6 30 | 6 32 | 6 34 | 6 36 | 6 39 | 6 41 | 6 43 | 6 46 | 6 49 | 6 52 | 6 55 | 6 58 | 7 02 | 7 06 | 7 11 | 7 15 | S. | |
| 35 | R. | 6 03 | 6 00 | 5 56 | 5 52 | 5 49 | 5 45 | 5 41 | 5 38 | 5 34 | 5 31 | 5 27 | 5 23 | 5 20 | 5 16 | 5 12 | 5 09 | 5 06 | 5 02 | 4 59 | 4 56 | 4 52 | 4 49 | 4 47 | 4 45 | 4 46 | R. | 35 |
| | S. | 6 12 | 6 14 | 6 16 | 6 18 | 6 20 | 6 22 | 6 24 | 6 26 | 6 28 | 6 31 | 6 33 | 6 35 | 6 38 | 6 40 | 6 42 | 6 45 | 6 48 | 6 51 | 6 54 | 6 57 | 7 00 | 7 04 | 7 09 | 7 13 | 7 18 | S. | |
| 36 | R. | 6 03 | 6 00 | 5 56 | 5 52 | 5 48 | 5 45 | 5 41 | 5 37 | 5 33 | 5 30 | 5 26 | 5 22 | 5 18 | 5 15 | 5 11 | 5 08 | 5 04 | 5 00 | 4 57 | 4 53 | 4 50 | 4 47 | 4 44 | 4 42 | 4 43 | R. | 36 |
| | S. | 6 12 | 6 14 | 6 16 | 6 18 | 6 20 | 6 23 | 6 25 | 6 27 | 6 29 | 6 32 | 6 34 | 6 36 | 6 39 | 6 42 | 6 44 | 6 47 | 6 50 | 6 53 | 6 56 | 6 59 | 7 03 | 7 07 | 7 11 | 7 16 | 7 21 | S. | |
| 37 | R. | 6 03 | 5 59 | 5 55 | 5 52 | 5 48 | 5 44 | 5 40 | 5 36 | 5 32 | 5 28 | 5 24 | 5 21 | 5 17 | 5 13 | 5 09 | 5 06 | 5 02 | 4 58 | 4 54 | 4 51 | 4 47 | 4 44 | 4 41 | 4 39 | 4 40 | R. | 37 |
| | S. | 6 12 | 6 14 | 6 16 | 6 19 | 6 21 | 6 24 | 6 26 | 6 28 | 6 30 | 6 33 | 6 35 | 6 38 | 6 41 | 6 43 | 6 46 | 6 49 | 6 52 | 6 55 | 6 58 | 7 02 | 7 05 | 7 09 | 7 14 | 7 19 | 7 24 | S. | |
| 38 | R. | 6 02 | 5 59 | 5 55 | 5 51 | 5 47 | 5 43 | 5 39 | 5 35 | 5 31 | 5 27 | 5 23 | 5 19 | 5 15 | 5 12 | 5 08 | 5 04 | 5 00 | 4 56 | 4 52 | 4 49 | 4 45 | 4 41 | 4 38 | 4 36 | 4 37 | R. | 38 |
| | S. | 6 12 | 6 14 | 6 16 | 6 19 | 6 21 | 6 24 | 6 26 | 6 28 | 6 31 | 6 34 | 6 36 | 6 39 | 6 42 | 6 45 | 6 48 | 6 51 | 6 54 | 6 57 | 7 00 | 7 04 | 7 08 | 7 12 | 7 17 | 7 22 | 7 27 | S. | |
| 39 | R. | 6 02 | 5 59 | 5 55 | 5 51 | 5 47 | 5 43 | 5 38 | 5 34 | 5 30 | 5 26 | 5 22 | 5 18 | 5 14 | 5 10 | 5 06 | 5 02 | 4 58 | 4 54 | 4 50 | 4 46 | 4 42 | 4 39 | 4 36 | 4 33 | 4 34 | R. | 39 |
| | S. | 6 12 | 6 15 | 6 17 | 6 20 | 6 22 | 6 25 | 6 27 | 6 29 | 6 32 | 6 35 | 6 38 | 6 41 | 6 44 | 6 47 | 6 50 | 6 53 | 6 56 | 6 59 | 7 03 | 7 06 | 7 10 | 7 15 | 7 20 | 7 25 | 7 30 | S. | |
| 40 | R. | 6 02 | 5 58 | 5 54 | 5 50 | 5 46 | 5 42 | 5 38 | 5 33 | 5 29 | 5 25 | 5 21 | 5 17 | 5 12 | 5 08 | 5 04 | 5 00 | 4 56 | 4 52 | 4 48 | 4 44 | 4 40 | 4 36 | 4 33 | 4 30 | 4 31 | R. | 40 |
| | S. | 6 12 | 6 15 | 6 17 | 6 20 | 6 22 | 6 25 | 6 28 | 6 30 | 6 33 | 6 36 | 6 39 | 6 42 | 6 45 | 6 48 | 6 51 | 6 54 | 6 58 | 7 01 | 7 05 | 7 09 | 7 13 | 7 18 | 7 23 | 7 28 | 7 33 | S. | |

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 41° to 60°—March 21 to June 22.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]

The table gives, for latitudes 41° through 60° N (column headers across the top and bottom: 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60), each split into R. and S. sub-columns, the mean times of sunrise (R.) and sunset (S.) for approximate dates and corresponding solar declinations.

Row headings (Approx. date / Dec. N.):

JUNE 22 — 23°27′; JUNE 10 — 23°; JUNE 1 — 22°; MAY 26 — 21°; MAY 21 — 20°; MAY 16 — 19°; MAY 12 — 18°; MAY 8 — 17°; MAY 5 — 16°; MAY 1 — 15°; APRIL 28 — 14°; APRIL 25 — 13°; APRIL 22 — 12°; APRIL 19 — 11°; APRIL 16 — 10°; APRIL 13 — 9°; APRIL 11 — 8°; APRIL 8 — 7°; APRIL 5 — 6°; APRIL 3 — 5°; MARCH 31 — 4°; MARCH 28 — 3°; MARCH 26 — 2°; MARCH 23 — 1°; MARCH 21 — 0°.

# TABLE 10.

### Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°.—June 22 to September 23.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]

| Approx. date | Dec. N. | Lat. N. → |
|---|---|---|
| SEPTEMBER 23 | 0° | |
| 21 | 1° | |
| 18 | 2° | |
| 16 | 3° | |
| 13 | 4° | |
| 10 | 5° | |
| 8 | 6° | |
| 5 | 7° | |
| 2 | 8° | |
| AUGUST 30 | 9° | |
| 28 | 10° | |
| 25 | 11° | |
| 22 | 12° | |
| 19 | 13° | |
| 16 | 14° | |
| 12 | 15° | |
| 9 | 16° | |
| 5 | 17° | |
| 2 | 18° | |
| JULY 28 | 19° | |
| 24 | 20° | |
| 19 | 21° | |
| 12 | 22° | |
| 8 | 23° | |
| JUNE 22 | 23° 27′ | |

TABLE 10. [Page 489

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 21° to 40°.—June 22 to September 23.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

| Lat. N. | Approx. date | Dec. N. | SEPTEMBER | | | | | | | | | | AUGUST | | | | | | | | | JULY | | | | JUNE | Approx. date | Lat. N. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 23 | 21 | 18 | 16 | 13 | 10 | 8 | 5 | 1 | 30 | 28 | 25 | 22 | 19 | 16 | 12 | 9 | 5 | 2 | 28 | 24 | 19 | 12 | 3 | 22 | | |

*(Detailed numerical rise/set values omitted — table of hours and minutes for latitudes 21° through 40°.)*

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 41° to 60°.—June 22 to September 23.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]



Mean Time of Sun's Visible Rising and Setting table for North Latitude 41° to 60°, covering June 22 to September 23, with columns for JUNE, JULY, AUGUST, and SEPTEMBER by approximate date and declination.

TABLE 10. [Page 491

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°—September 23 to December 22.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 21° to 40°—September 23 to December 22.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

### North Latitude: 41° to 60°—September 23 to December 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

| Lat. N. | Approx. date. | SEPTEMBER. | | | OCTOBER. | | | | | | | | | | | | NOVEMBER. | | | | | | | DECEMBER. | | | Approx. date. | Lat. N. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 23 | 26 | 28 | 1 | 4 | 6 | 9 | 11 | 14 | 17 | 19 | 22 | 25 | 28 | 31 | 3 | 6 | 10 | 14 | 17 | 22 | 27 | 3 | 11 | 22 | | |
| | Dec. S. | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 23° 27′ | Dec. S. | |
| ° | | h. m. | h. m. | h. m. | h. m. | h. m | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | | ° |
| 41 | R. | 5 47 | 5 50 | 5 53 | 5 55 | 5 58 | 6 01 | 6 04 | 6 06 | 6 09 | 6 12 | 6 15 | 6 18 | 6 22 | 6 25 | 6 29 | 6 32 | 6 36 | 6 40 | 6 45 | 6 50 | 6 55 | 7 00 | 7 06 | 7 14 | 7 21 | R. | 41 |
| | S. | 5 57 | 5 53 | 5 49 | 5 44 | 5 40 | 5 36 | 5 32 | 5 27 | 5 23 | 5 19 | 5 15 | 5 11 | 5 07 | 5 03 | 4 59 | 4 55 | 4 51 | 4 47 | 4 44 | 4 41 | 4 38 | 4 35 | 4 33 | 4 82 | 4 35 | S. | |
| 42 | R. | 5 47 | 5 50 | 5 53 | 5 55 | 5 58 | 6 01 | 6 04 | 6 07 | 6 10 | 6 13 | 6 16 | 6 20 | 6 23 | 6 26 | 6 30 | 6 34 | 6 38 | 6 42 | 6 47 | 6 52 | 6 57 | 7 03 | 7 09 | 7 17 | 7 24 | R. | 42 |
| | S. | 5 57 | 5 53 | 5 49 | 5 44 | 5 39 | 5 35 | 5 31 | 5 27 | 5 22 | 5 18 | 5 14 | 5 10 | 5 05 | 5 01 | 4 57 | 4 53 | 4 49 | 4 45 | 4 42 | 4 39 | 4 35 | 4 33 | 4 30 | 4 29 | 4 32 | S. | |
| 43 | R. | 5 47 | 5 50 | 5 53 | 5 56 | 5 59 | 6 02 | 6 05 | 6 08 | 6 11 | 6 14 | 6 18 | 6 21 | 6 25 | 6 28 | 6 32 | 6 36 | 6 40 | 6 44 | 6 49 | 6 54 | 7 00 | 7 06 | 7 12 | 7 20 | 7 28 | R. | 43 |
| | S. | 5 57 | 5 53 | 5 48 | 5 44 | 5 39 | 5 35 | 5 30 | 5 26 | 5 21 | 5 17 | 5 13 | 5 08 | 5 04 | 4 59 | 4 55 | 4 51 | 4 47 | 4 43 | 4 39 | 4 36 | 4 33 | 4 30 | 4 27 | 4 26 | 4 29 | S. | |
| 44 | R. | 5 47 | 5 50 | 5 53 | 5 56 | 5 59 | 6 02 | 6 06 | 6 09 | 6 12 | 6 16 | 6 19 | 6 23 | 6 26 | 6 30 | 6 34 | 6 38 | 6 42 | 6 47 | 6 52 | 6 57 | 7 03 | 7 09 | 7 15 | 7 24 | 7 31 | R. | 44 |
| | S. | 5 58 | 5 53 | 5 48 | 5 44 | 5 39 | 5 34 | 5 30 | 5 25 | 5 20 | 5 16 | 5 11 | 5 07 | 5 02 | 4 58 | 4 54 | 4 49 | 4 45 | 4 41 | 4 37 | 4 33 | 4 30 | 4 27 | 4 24 | 4 23 | 4 25 | S. | |
| 45 | R. | 5 47 | 5 50 | 5 53 | 5 56 | 5 59 | 6 03 | 6 06 | 6 09 | 6 13 | 6 17 | 6 20 | 6 24 | 6 28 | 6 31 | 6 36 | 6 40 | 6 45 | 6 49 | 6 54 | 7 00 | 7 06 | 7 12 | 7 19 | 7 27 | 7 35 | R. | 45 |
| | S. | 5 58 | 5 53 | 5 48 | 5 43 | 5 38 | 5 34 | 5 29 | 5 24 | 5 19 | 5 15 | 5 10 | 5 05 | 5 01 | 4 56 | 4 52 | 4 47 | 4 43 | 4 38 | 4 34 | 4 31 | 4 27 | 4 24 | 4 21 | 4 19 | 4 22 | S. | |
| 46 | R. | 5 47 | 5 50 | 5 53 | 5 56 | 6 00 | 6 03 | 6 07 | 6 10 | 6 14 | 6 18 | 6 22 | 6 26 | 6 29 | 6 33 | 6 38 | 6 42 | 6 47 | 6 52 | 6 57 | 7 03 | 7 09 | 7 15 | 7 22 | 7 31 | 7 38 | R. | 46 |
| | S. | 5 58 | 5 53 | 5 48 | 5 43 | 5 38 | 5 33 | 5 28 | 5 23 | 5 18 | 5 14 | 5 09 | 5 04 | 4 59 | 4 54 | 4 50 | 4 45 | 4 41 | 4 36 | 4 32 | 4 28 | 4 24 | 4 20 | 4 17 | 4 16 | 4 18 | S. | |
| 47 | R. | 5 47 | 5 50 | 5 54 | 5 57 | 6 01 | 6 04 | 6 08 | 6 11 | 6 15 | 6 19 | 6 23 | 6 27 | 6 31 | 6 35 | 6 40 | 6 44 | 6 49 | 6 54 | 7 00 | 7 06 | 7 12 | 7 19 | 7 26 | 7 35 | 7 42 | R. | 47 |
| | S. | 5 58 | 5 53 | 5 48 | 5 43 | 5 38 | 5 33 | 5 28 | 5 22 | 5 17 | 5 12 | 5 07 | 5 02 | 4 57 | 4 53 | 4 48 | 4 43 | 4 38 | 4 33 | 4 29 | 4 25 | 4 21 | 4 17 | 4 14 | 4 12 | 4 14 | S. | |
| 48 | R. | 5 47 | 5 50 | 5 54 | 5 57 | 6 01 | 6 05 | 6 09 | 6 12 | 6 16 | 6 20 | 6 25 | 6 29 | 6 33 | 6 37 | 6 42 | 6 47 | 6 52 | 6 57 | 7 03 | 7 09 | 7 15 | 7 22 | 7 30 | 7 39 | 7 46 | R. | 48 |
| | S. | 5 58 | 5 53 | 5 48 | 5 42 | 5 37 | 5 32 | 5 27 | 5 21 | 5 16 | 5 11 | 5 06 | 5 01 | 4 56 | 4 51 | 4 46 | 4 41 | 4 36 | 4 31 | 4 26 | 4 22 | 4 17 | 4 13 | 4 10 | 4 08 | 4 10 | S. | |
| 49 | R. | 5 47 | 5 50 | 5 54 | 5 58 | 6 02 | 6 05 | 6 09 | 6 13 | 6 18 | 6 22 | 6 26 | 6 30 | 6 35 | 6 39 | 6 44 | 6 49 | 6 55 | 7 00 | 7 06 | 7 12 | 7 19 | 7 26 | 7 34 | 7 43 | 7 51 | R. | 49 |
| | S. | 5 58 | 5 53 | 5 48 | 5 42 | 5 37 | 5 31 | 5 26 | 5 20 | 5 15 | 5 10 | 5 04 | 4 59 | 4 54 | 4 49 | 4 43 | 4 38 | 4 33 | 4 28 | 4 23 | 4 18 | 4 14 | 4 10 | 4 06 | 4 04 | 4 06 | S. | |
| 50 | R. | 5 46 | 5 50 | 5 54 | 5 58 | 6 02 | 6 06 | 6 10 | 6 14 | 6 19 | 6 23 | 6 28 | 6 32 | 6 37 | 6 41 | 6 47 | 6 52 | 6 57 | 7 03 | 7 09 | 7 16 | 7 23 | 7 30 | 7 38 | 7 47 | 7 55 | R. | 50 |
| | S. | 5 58 | 5 53 | 5 47 | 5 41 | 5 36 | 5 30 | 5 25 | 5 19 | 5 14 | 5 08 | 5 03 | 4 57 | 4 52 | 4 46 | 4 41 | 4 36 | 4 30 | 4 25 | 4 20 | 4 15 | 4 10 | 4 06 | 4 02 | 3 59 | 4 01 | S. | |
| 51 | R. | 5 46 | 5 50 | 5 55 | 5 59 | 6 03 | 6 07 | 6 11 | 6 16 | 6 20 | 6 25 | 6 29 | 6 34 | 6 39 | 6 44 | 6 49 | 6 55 | 7 00 | 7 06 | 7 12 | 7 19 | 7 26 | 7 34 | 7 42 | 7 52 | 8 00 | R. | 51 |
| | S. | 5 58 | 5 52 | 5 47 | 5 41 | 5 35 | 5 29 | 5 24 | 5 18 | 5 12 | 5 07 | 5 01 | 4 56 | 4 50 | 4 44 | 4 38 | 4 33 | 4 27 | 4 22 | 4 16 | 4 11 | 4 06 | 4 02 | 3 57 | 3 55 | 3 56 | S. | |
| 52 | R. | 5 46 | 5 50 | 5 55 | 5 59 | 6 04 | 6 08 | 6 12 | 6 17 | 6 21 | 6 26 | 6 31 | 6 36 | 6 41 | 6 46 | 6 52 | 6 57 | 7 03 | 7 09 | 7 16 | 7 23 | 7 30 | 7 38 | 7 47 | 7 57 | 8 05 | R. | 52 |
| | S. | 5 58 | 5 52 | 5 47 | 5 41 | 5 35 | 5 29 | 5 23 | 5 17 | 5 11 | 5 05 | 5 00 | 4 54 | 4 48 | 4 42 | 4 36 | 4 30 | 4 24 | 4 18 | 4 13 | 4 08 | 4 02 | 3 57 | 3 53 | 3 50 | 3 51 | S. | |
| 53 | R. | 5 46 | 5 50 | 5 55 | 5 59 | 6 04 | 6 09 | 6 13 | 6 18 | 6 23 | 6 28 | 6 33 | 6 38 | 6 43 | 6 48 | 6 54 | 7 00 | 7 06 | 7 13 | 7 19 | 7 27 | 7 35 | 7 43 | 7 52 | 8 02 | 8 11 | R. | 53 |
| | S. | 5 58 | 5 52 | 5 46 | 5 40 | 5 34 | 5 28 | 5 22 | 5 16 | 5 10 | 5 04 | 4 58 | 4 52 | 4 45 | 4 39 | 4 33 | 4 27 | 4 21 | 4 15 | 4 09 | 4 04 | 3 58 | 3 53 | 3 48 | 3 44 | 3 46 | S. | |
| 54 | R. | 5 46 | 5 50 | 5 55 | 6 00 | 6 05 | 6 09 | 6 14 | 6 19 | 6 24 | 6 29 | 6 35 | 6 40 | 6 45 | 6 51 | 6 57 | 7 03 | 7 10 | 7 16 | 7 23 | 7 31 | 7 39 | 7 48 | 7 57 | 8 08 | 8 16 | R. | 54 |
| | S. | 5 59 | 5 52 | 5 46 | 5 40 | 5 34 | 5 27 | 5 21 | 5 15 | 5 08 | 5 02 | 4 56 | 4 50 | 4 43 | 4 37 | 4 30 | 4 24 | 4 18 | 4 11 | 4 05 | 4 00 | 3 54 | 3 48 | 3 43 | 3 39 | 3 40 | S. | |
| 55 | R. | 5 46 | 5 50 | 5 55 | 6 00 | 6 05 | 6 10 | 6 15 | 6 20 | 6 26 | 6 31 | 6 37 | 6 42 | 6 48 | 6 54 | 7 00 | 7 07 | 7 13 | 7 20 | 7 27 | 7 35 | 7 44 | 7 53 | 8 02 | 8 13 | 8 22 | R. | 55 |
| | S. | 5 59 | 5 52 | 5 46 | 5 39 | 5 33 | 5 26 | 5 20 | 5 13 | 5 07 | 5 00 | 4 54 | 4 47 | 4 41 | 4 34 | 4 27 | 4 21 | 4 14 | 4 08 | 4 01 | 3 55 | 3 49 | 3 43 | 3 37 | 3 33 | 3 34 | S. | |
| 56 | R. | 5 45 | 5 50 | 5 56 | 6 01 | 6 06 | 6 11 | 6 17 | 6 22 | 6 27 | 6 33 | 6 39 | 6 45 | 6 51 | 6 57 | 7 03 | 7 10 | 7 17 | 7 24 | 7 32 | 7 40 | 7 49 | 7 58 | 8 08 | 8 20 | 8 29 | R. | 56 |
| | S. | 5 59 | 5 52 | 5 46 | 5 39 | 5 32 | 5 25 | 5 19 | 5 12 | 5 05 | 4 58 | 4 52 | 4 45 | 4 38 | 4 31 | 4 24 | 4 17 | 4 11 | 4 04 | 3 57 | 3 50 | 3 44 | 3 37 | 3 31 | 3 27 | 3 27 | S. | |
| 57 | R. | 5 45 | 5 50 | 5 56 | 6 01 | 6 06 | 6 12 | 6 18 | 6 23 | 6 29 | 6 35 | 6 41 | 6 47 | 6 53 | 7 00 | 7 07 | 7 14 | 7 21 | 7 28 | 7 36 | 7 45 | 7 54 | 8 04 | 8 14 | 8 27 | 8 36 | R. | 57 |
| | S. | 5 59 | 5 52 | 5 45 | 5 38 | 5 31 | 5 24 | 5 17 | 5 10 | 5 03 | 4 56 | 4 49 | 4 42 | 4 35 | 4 28 | 4 21 | 4 14 | 4 07 | 3 59 | 3 52 | 3 45 | 3 38 | 3 31 | 3 25 | 3 20 | 3 20 | S. | |
| 58 | R. | 5 45 | 5 50 | 5 56 | 6 02 | 6 07 | 6 13 | 6 19 | 6 25 | 6 31 | 6 37 | 6 43 | 6 50 | 6 56 | 7 03 | 7 10 | 7 17 | 7 25 | 7 33 | 7 41 | 7 50 | 8 00 | 8 10 | 8 21 | 8 34 | 8 44 | R. | 58 |
| | S. | 5 59 | 5 52 | 5 45 | 5 38 | 5 31 | 5 23 | 5 16 | 5 09 | 5 02 | 4 54 | 4 47 | 4 40 | 4 32 | 4 25 | 4 17 | 4 10 | 4 03 | 3 55 | 3 47 | 3 40 | 3 33 | 3 25 | 3 18 | 3 13 | 3 13 | S. | |
| 59 | R. | 5 45 | 5 51 | 5 57 | 6 02 | 6 08 | 6 14 | 6 21 | 6 27 | 6 33 | 6 39 | 6 46 | 6 52 | 6 59 | 7 06 | 7 14 | 7 21 | 7 29 | 7 38 | 7 47 | 7 56 | 8 06 | 8 17 | 8 28 | 8 42 | 8 52 | R. | 59 |
| | S. | 6 00 | 5 52 | 5 45 | 5 37 | 5 30 | 5 22 | 5 15 | 5 07 | 5 00 | 4 52 | 4 45 | 4 37 | 4 29 | 4 21 | 4 14 | 4 06 | 3 58 | 3 50 | 3 42 | 3 35 | 3 27 | 3 19 | 3 11 | 3 05 | 3 05 | S. | |
| 60 | R. | 5 45 | 5 51 | 5 57 | 6 03 | 6 09 | 6 16 | 6 22 | 6 28 | 6 35 | 6 42 | 6 48 | 6 55 | 7 02 | 7 10 | 7 18 | 7 26 | 7 34 | 7 43 | 7 52 | 8 02 | 8 13 | 8 24 | 8 36 | 8 51 | 9 01 | R. | 60 |
| | S. | 6 00 | 5 52 | 5 44 | 5 36 | 5 29 | 5 21 | 5 13 | 5 05 | 4 58 | 4 50 | 4 42 | 4 34 | 4 26 | 4 18 | 4 10 | 4 02 | 3 53 | 3 45 | 3 36 | 3 28 | 3 20 | 3 12 | 3 03 | 2 56 | 2 56 | S. | |

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 0° to 20°.—December 22 to March 21.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]



A dense numerical table giving the mean time of the sun's visible rising (R) and setting (S) for north latitudes 0° through 20°, with columns for approximate dates in December, January, February, and March, and corresponding solar declinations. Times are given in hours and minutes (h. m.).

TABLE 10. [Page 495

## Mean Time of Sun's Visible Rising and Setting.

North Latitude: 21° to 40°.—December 22 to March 21.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

# TABLE 10.

### Mean Time of Sun's Visible Rising and Setting.

North Latitude: 41° to 60°—December 22 to March 21.

[R=Local mean time of sun's visible rising, S=Local mean time of sun's visible setting.]

| | | Lat. N. | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Approx. date | Dec. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. |
| **MARCH** | 21 | 0° | 6 02 | 6 12 | 6 02 | 6 12 | 6 02 | 6 02 | 6 02 | 6 13 | 6 02 | 6 13 | 6 02 | 6 13 | 6 02 | 6 13 | 6 02 | 6 14 | 6 02 | 6 14 | 6 01 | 6 15 |
| | 18 | 1° | 6 07 | 6 10 | 6 07 | 6 10 | 6 07 | 6 07 | 6 07 | 6 10 | 6 07 | 6 10 | 6 07 | 6 09 | 6 07 | 6 09 | 6 07 | 6 09 | 6 07 | 6 09 | 6 08 | 6 09 |
| | 16 | 2° | 6 11 | 6 07 | 6 11 | 6 07 | 6 11 | 6 06 | 6 11 | 6 06 | 6 11 | 6 06 | 6 12 | 6 05 | 6 12 | 6 05 | 6 13 | 6 04 | 6 13 | 6 03 | 6 15 | 6 02 |
| | 13 | 3° | 6 15 | 6 04 | 6 15 | 6 04 | 6 16 | 6 04 | 6 16 | 6 03 | 6 16 | 6 03 | 6 18 | 6 02 | 6 19 | 6 00 | 6 20 | 5 59 | 6 21 | 5 58 | 6 23 | 5 56 |
| | 11 | 4° | 6 19 | 6 01 | 6 20 | 6 01 | 6 20 | 6 00 | 6 21 | 6 00 | 6 21 | 5 59 | 6 22 | 5 59 | 6 24 | 5 56 | 6 25 | 5 55 | 6 27 | 5 53 | 6 29 | 5 51 |
| | 8 | 5° | 6 24 | 5 59 | 6 24 | 5 58 | 6 25 | 5 58 | 6 25 | 5 57 | 6 26 | 5 57 | 6 28 | 5 55 | 6 30 | 5 52 | 6 31 | 5 51 | 6 34 | 5 48 | 6 36 | 5 44 |
| | 6 | 6° | 6 28 | 5 55 | 6 28 | 5 55 | 6 29 | 5 54 | 6 30 | 5 54 | 6 30 | 5 53 | 6 35 | 5 48 | 6 36 | 5 47 | 6 38 | 5 45 | 6 41 | 5 43 | 6 46 | 5 37 |
| | 3 | 7° | 6 32 | 5 53 | 6 32 | 5 52 | 6 33 | 5 51 | 6 34 | 5 50 | 6 35 | 5 50 | 6 41 | 5 42 | 6 42 | 5 41 | 6 44 | 5 40 | 6 47 | 5 36 | 6 54 | 5 31 |
| | 1 | 8° | 6 36 | 5 50 | 6 37 | 5 49 | 6 38 | 5 49 | 6 39 | 5 47 | 6 40 | 5 46 | 6 47 | 5 38 | 6 48 | 5 36 | 6 51 | 5 33 | 6 54 | 5 28 | 7 01 | 5 24 |
| **FEBRUARY** | 26 | 9° | 6 40 | 5 47 | 6 41 | 5 46 | 6 42 | 5 45 | 6 43 | 5 44 | 6 44 | 5 42 | 6 52 | 5 34 | 6 54 | 5 33 | 6 55 | 5 28 | 7 01 | 5 22 | 7 09 | 5 17 |
| | 23 | 10° | 6 44 | 5 44 | 6 45 | 5 43 | 6 46 | 5 41 | 6 48 | 5 39 | 6 49 | 5 39 | 6 58 | 5 28 | 6 59 | 5 26 | 7 02 | 5 16 | 7 07 | 5 11 | 7 17 | 5 10 |
| | 20 | 11° | 6 48 | 5 40 | 6 49 | 5 39 | 6 50 | 5 36 | 6 52 | 5 36 | 6 53 | 5 35 | 7 04 | 5 21 | 7 07 | 5 19 | 7 09 | 5 09 | 7 14 | 5 06 | 7 24 | 5 03 |
| | 18 | 12° | 6 52 | 5 37 | 6 53 | 5 35 | 6 55 | 5 34 | 6 56 | 5 32 | 6 58 | 5 31 | 7 09 | 5 17 | 7 13 | 5 13 | 7 15 | 5 11 | 7 21 | 4 59 | 7 32 | 4 56 |
| | 15 | 13° | 6 55 | 5 33 | 6 57 | 5 32 | 6 59 | 5 30 | 7 00 | 5 28 | 7 02 | 5 27 | 7 14 | 5 12 | 7 16 | 5 10 | 7 21 | 5 04 | 7 27 | 4 52 | 7 40 | 4 48 |
| | 12 | 14° | 6 59 | 5 29 | 7 01 | 5 28 | 7 03 | 5 24 | 7 06 | 5 22 | 7 08 | 5 20 | 7 20 | 5 05 | 7 25 | 5 01 | 7 34 | 4 48 | 7 44 | 4 44 | 7 48 | 4 40 |
| | 9 | 15° | 7 03 | 5 26 | 7 05 | 5 24 | 7 07 | 5 22 | 7 09 | 5 11 | 7 18 | 5 06 | 7 25 | 5 01 | 7 34 | 4 55 | 7 41 | 4 48 | 7 52 | 4 37 | 7 56 | 4 32 |
| | 5 | 16° | 7 07 | 5 20 | 7 09 | 5 18 | 7 13 | 5 16 | 7 15 | 5 13 | 7 22 | 5 01 | 7 31 | 4 55 | 7 37 | 4 48 | 7 47 | 4 41 | 8 00 | 4 29 | 8 05 | 4 24 |
| | 2 | 17° | 7 10 | 5 17 | 7 12 | 5 14 | 7 17 | 5 11 | 7 19 | 5 08 | 7 27 | 4 58 | 7 36 | 4 49 | 7 47 | 4 41 | 7 50 | 4 20 | 8 08 | 4 13 | 8 15 | 4 15 |
| **JANUARY** | 29 | 18° | 7 14 | 5 13 | 7 16 | 5 11 | 7 18 | 5 08 | 7 23 | 5 03 | 7 32 | 4 49 | 7 45 | 4 45 | 7 52 | 4 34 | 8 01 | 4 26 | 8 11 | 4 11 | 8 21 | 4 05 |
| | 25 | 19° | 7 17 | 5 08 | 7 19 | 5 06 | 7 24 | 5 03 | 7 30 | 4 55 | 7 46 | 4 42 | 7 58 | 4 33 | 8 07 | 4 17 | 8 23 | 4 02 | 8 29 | 3 55 | 8 55 | 3 55 |
| | 21 | 20° | 7 20 | 5 03 | 7 22 | 5 00 | 7 28 | 4 55 | 7 40 | 4 44 | 7 51 | 4 27 | 8 04 | 4 19 | 8 18 | 4 05 | 8 31 | 3 45 | | | | |
| | 16 | 21° | 7 22 | 4 57 | 7 25 | 4 54 | 7 34 | 4 46 | 7 66 | 4 20 | 8 05 | 4 06 | 8 20 | 3 54 | 8 32 | 3 41 | | | | | | |
| | 10 | 22° | 7 24 | 4 51 | 7 27 | 4 48 | 7 42 | 4 36 | 8 00 | 4 06 | 8 15 | 3 46 | 8 26 | 3 39 | 8 54 | 3 21 | | | | | | |
| | 5 | 23° | 7 25 | 4 43 | 7 28 | 4 40 | 7 53 | 4 18 | 8 02 | 4 00 | 8 18 | 3 44 | 8 30 | 3 30 | 9 06 | 3 06 | | | | | | |
| **DECEMBER** | 22 | 23° 27' | 7 21 | 4 24 | 7 32 | 4 22 | 7 46 | 4 01 | 8 00 | 3 46 | 8 16 | 3 24 | 8 27 | 3 20 | 9 01 | 2 56 | | | | | | |

TABLE 10. [Page 497

## Mean Time of Sun's Visible Rising and Setting.

South latitude: 0° to 20°—March 21 to June 22.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]

| Lat. S. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

JUNE.

MAY.

APRIL.

MARCH.

6583—06——32

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

South latitude: 21° to 40°—March 21 to June 22.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

| Approx. date | Dec. N. | Lat. S. 21° | 22° | 23° | 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | 38° | 39° | 40° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. |

*JUNE — June 22 (23° 27'), June 10 (23°), June 1 (22°)*

*MAY — May 26 (21°), May 21 (20°), May 16 (19°), May 12 (18°), May 8 (17°), May 5 (16°), May 1 (15°)*

*APRIL — Apr 28 (14°), Apr 25 (13°), Apr 22 (12°), Apr 19 (11°), Apr 16 (10°), Apr 13 (9°), Apr 11 (8°), Apr 8 (7°), Apr 5 (6°), Apr 3 (5°), Apr 1 (4°)*

*MARCH — Mar 28 (3°), Mar 26 (2°), Mar 23 (1°), Mar 21 (0°)*

# TABLE 10.

[Page 499

### Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°—March 21 to June 22.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]

| Lat. S. | JUNE 22 (23°27') | JUNE 10 (23°) | JUNE 1 (22°) | MAY 26 (21°) | MAY 21 (20°) | MAY 16 (19°) | MAY 12 (18°) | MAY 8 (17°) | MAY 5 (16°) | MAY 1 (15°) | APR 28 (14°) | APR 25 (13°) | APR 22 (12°) | APR 19 (11°) | APR 16 (10°) | APR 13 (9°) | APR 11 (8°) | APR 8 (7°) | APR 5 (6°) | APR 3 (5°) | MAR 31 (4°) | MAR 28 (3°) | MAR 26 (2°) | MAR 23 (1°) | MAR 21 (0°) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 R. | 7 25 | 7 20 | 7 14 | 7 09 | 7 05 | 7 01 | 6 57 | 6 53 | 6 49 | 6 46 | 6 43 | 6 39 | 6 36 | 6 33 | 6 30 | 6 27 | 6 24 | 6 21 | 6 19 | 6 16 | 6 13 | 6 11 | 6 08 | 6 05 | 6 02 |
| 41 S. | 4 39 | 4 38 | 4 41 | 4 44 | 4 48 | 4 52 | 4 56 | 5 00 | 5 04 | 5 09 | 5 13 | 5 17 | 5 21 | 5 26 | 5 30 | 5 34 | 5 38 | 5 42 | 5 47 | 5 51 | 5 55 | 6 00 | 6 04 | 6 08 | 6 12 |
| 42 R. | 7 28 | 7 23 | 7 17 | 7 12 | 7 07 | 7 03 | 6 59 | 6 55 | 6 51 | 6 48 | 6 44 | 6 41 | 6 38 | 6 34 | 6 31 | 6 28 | 6 25 | 6 22 | 6 19 | 6 17 | 6 14 | 6 11 | 6 08 | 6 05 | 6 02 |
| 42 S. | | | | | | | | | | | | | | | | | | | | | | | | | 6 12 |
| 43 R. | 7 31 | 7 26 | 7 20 | 7 15 | 7 10 | 7 05 | 6 59 | 6 58 | 6 53 | 6 50 | 6 46 | 6 43 | 6 39 | 6 36 | 6 32 | 6 29 | 6 26 | 6 23 | 6 20 | 6 17 | 6 14 | 6 11 | 6 08 | 6 05 | 6 02 |
| 44 R. | 7 33 | 7 30 | 7 26 | 7 21 | 7 16 | 7 11 | 7 06 | 7 01 | 6 57 | 6 53 | 6 49 | 6 45 | 6 41 | 6 37 | 6 33 | 6 30 | 6 26 | 6 23 | 6 20 | 6 17 | 6 14 | 6 11 | 6 08 | 6 05 | 6 02 |
| 45 R. | 7 38 | 7 35 | 7 31 | 7 26 | 7 21 | 7 16 | 7 11 | 7 06 | 7 01 | 6 57 | 6 53 | 6 49 | 6 45 | 6 41 | 6 37 | 6 33 | 6 29 | 6 25 | 6 22 | 6 19 | 6 16 | 6 13 | 6 10 | 6 07 | 6 04 |
| 46 R. | 7 42 | 7 37 | 7 30 | 7 24 | 7 19 | 7 14 | 7 09 | 7 04 | 7 00 | 6 56 | 6 52 | 6 48 | 6 44 | 6 40 | 6 36 | 6 33 | 6 29 | 6 25 | 6 22 | 6 19 | 6 15 | 6 12 | 6 10 | 6 05 | 6 13 |
| 47 R. | 7 46 | 7 41 | 7 34 | 7 28 | 7 22 | 7 17 | 7 12 | 7 07 | 7 02 | 6 58 | 6 54 | 6 50 | 6 46 | 6 42 | 6 38 | 6 34 | 6 30 | 6 27 | 6 23 | 6 20 | 6 16 | 6 13 | 6 10 | 6 06 | 6 01 |
| 48 R. | 7 50 | 7 45 | 7 38 | 7 31 | 7 25 | 7 20 | 7 15 | 7 10 | 7 05 | 7 00 | 6 56 | 6 52 | 6 47 | 6 43 | 6 39 | 6 35 | 6 31 | 6 27 | 6 24 | 6 21 | 6 17 | 6 14 | 6 10 | 6 05 | 6 13 |
| 49 R. | 7 54 | 7 49 | 7 42 | 7 35 | 7 29 | 7 23 | 7 18 | 7 13 | 7 08 | 7 03 | 6 58 | 6 54 | 6 49 | 6 45 | 6 41 | 6 37 | 6 33 | 6 29 | 6 25 | 6 21 | 6 18 | 6 14 | 6 11 | 6 06 | 6 14 |
| 50 R. | 7 59 | 7 53 | 7 46 | 7 39 | 7 32 | 7 27 | 7 21 | 7 16 | 7 10 | 7 05 | 7 01 | 6 56 | 6 51 | 6 47 | 6 42 | 6 38 | 6 34 | 6 30 | 6 26 | 6 22 | 6 18 | 6 15 | 6 11 | 6 08 | 6 01 |
| 51 R. | 8 04 | 7 58 | 7 50 | 7 43 | 7 36 | 7 30 | 7 24 | 7 18 | 7 13 | 7 08 | 7 03 | 6 58 | 6 53 | 6 48 | 6 44 | 6 48 | 6 35 | 6 31 | 6 27 | 6 23 | 6 19 | 6 16 | 6 12 | 6 08 | 6 13 |
| 52 R. | 8 09 | 8 03 | 7 55 | 7 47 | 7 40 | 7 34 | 7 28 | 7 22 | 7 16 | 7 11 | 7 06 | 7 00 | 6 55 | 6 50 | 6 45 | 6 41 | 6 36 | 6 32 | 6 28 | 6 24 | 6 20 | 6 17 | 6 12 | 6 08 | 6 01 |
| 53 R. | 8 14 | 8 08 | 8 01 | 7 52 | 7 45 | 7 38 | 7 31 | 7 25 | 7 19 | 7 14 | 7 08 | 7 03 | 6 58 | 6 52 | 6 47 | 6 43 | 6 38 | 6 33 | 6 29 | 6 25 | 6 21 | 6 17 | 6 13 | 6 08 | 6 13 |
| 54 R. | 8 20 | 8 14 | 8 05 | 7 57 | 7 48 | 7 41 | 7 34 | 7 27 | 7 21 | 7 15 | 7 09 | 7 04 | 6 58 | 6 54 | 6 49 | 6 44 | 6 40 | 6 35 | 6 30 | 6 26 | 6 22 | 6 18 | 6 14 | 6 06 | 6 14 |
| 55 R. | 8 26 | 8 19 | 8 10 | 8 02 | 7 54 | 7 46 | 7 39 | 7 32 | 7 25 | 7 19 | 7 13 | 7 08 | 7 02 | 6 57 | 6 51 | 6 46 | 6 41 | 6 36 | 6 31 | 6 27 | 6 23 | 6 18 | 6 14 | 6 07 | 6 15 |
| 56 R. | 8 33 | 8 26 | 8 16 | 8 07 | 7 58 | 7 51 | 7 44 | 7 37 | 7 30 | 7 24 | 7 18 | 7 11 | 7 05 | 6 59 | 6 53 | 6 48 | 6 42 | 6 37 | 6 32 | 6 27 | 6 21 | 6 16 | 6 11 | 6 06 | 6 11 |
| 57 R. | 8 31 | 8 33 | 8 39 | 8 46 | 8 54 | 8 01 | 8 09 | 8 17 | 8 24 | 8 31 | 8 38 | 8 45 | 8 52 | 8 59 | 9 06 | 9 13 | 9 20 | 9 27 | 9 34 | 9 41 | 9 48 | 9 55 | 10 02 | 10 08 | 10 14 |

# TABLE 10.

### Mean Time of Sun's Visible Rising and Setting.

South Latitude: 0° to 20°.—June 22 to September 23.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]

Columns (Lat. S.): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Month/Date groups with Approx. date and Dec. N.:

| Month | Date | Dec. N. |
|---|---|---|
| SEPTEMBER | 23 | 0° |
| | 21 | 1° |
| | 18 | 2° |
| | 16 | 3° |
| | 13 | 4° |
| | 10 | 5° |
| | 8 | 6° |
| | 5 | 7° |
| | 2 | 8° |
| AUGUST | 30 | 9° |
| | 28 | 10° |
| | 25 | 11° |
| | 22 | 12° |
| | 19 | 13° |
| | 16 | 14° |
| | 12 | 15° |
| | 9 | 16° |
| | 5 | 17° |
| | 2 | 18° |
| JULY | 28 | 19° |
| | 24 | 20° |
| | 19 | 21° |
| | 12 | 22° |
| | 3 | 23° |
| JUNE | 22 | 23° 27′ |

# TABLE 10.

[Page 501

## Mean Time of Sun's Visible Rising and Setting.

South Latitude: 21° to 40°.—June 22 to September 23.

[R = Local mean time of sun's visible rising.   S = Local mean time of sun's visible setting.]

This dense astronomical table gives, for each date (with the Sun's declination N, and approximate dates in SEPTEMBER, AUGUST, JULY, and JUNE) and for South Latitudes 21° through 40° (grouped 21–25, 26–30, 31–35, 36–40), the local mean time (h. m.) of the Sun's visible rising (R) and setting (S).



| Lat. S. ° | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Approx. date / Dec. N. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. | R./S. |

_(Full numeric rising/setting values are tabulated in the original for declinations 0° through 23°27′, corresponding to approximate dates Sept. 23 back to June 22.)_

# TABLE 10.

### Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°—June 22 to September 23.

[R = Local mean time of sun's visible rising.   S = Local mean time of sun's visible setting.]

TABLE 10. [Page 503

## Mean Time of Sun's Visible Rising and Setting.

South latitude: 0° to 20°—September 23 to December 22.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]

| Lat. S. | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| Approx. date. | Dec. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. | R. S. |

**DECEMBER.**

| Dec. 22 | 23° 27′ | | | | | | | | | | | | | | | | | | | | | |
| Dec. 11 | 23° | | | | | | | | | | | | | | | | | | | | | |
| Dec. 3 | 22° | | | | | | | | | | | | | | | | | | | | | |

**NOVEMBER.**

| 27 | 21° |
| 22 | 20° |
| 17 | 19° |
| 14 | 18° |
| 10 | 17° |
| 6 | 16° |
| 3 | 15° |

**OCTOBER.**

| 31 | 14° |
| 28 | 13° |
| 25 | 12° |
| 22 | 11° |
| 19 | 10° |
| 17 | 9° |
| 14 | 8° |
| 11 | 7° |
| 9 | 6° |
| 6 | 5° |
| 4 | 4° |
| 1 | 3° |

**SEPTEMBER.**

| 28 | 2° |
| 26 | 1° |
| 23 | 0° |

| Lat. S. | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

### South latitude: 21° to 40°—September 23 to December 22.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

| Lat. S. | Approx. date. | SEPTEMBER. | | | OCTOBER. | | | | | | | | | | | | NOVEMBER. | | | | | | | DECEMBER. | | | Approx. date. | Lat. S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 23 | 26 | 28 | 1 | 4 | 6 | 9 | 11 | 14 | 17 | 19 | 22 | 25 | 28 | 31 | 3 | 6 | 10 | 14 | 17 | 22 | 27 | 3 | 11 | 22 | | |
| | Dec. S. | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 23° 27′ | Dec. S. | |
| ° | | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | | ° |
| 21 | R. | 5 48 | 5 46 | 5 44 | 5 41 | 5 39 | 5 37 | 5 35 | 5 32 | 5 30 | 5 28 | 5 26 | 5 24 | 5 21 | 5 19 | 5 18 | 5 16 | 5 14 | 5 13 | 5 12 | 5 11 | 5 10 | 5 10 | 5 10 | 5 11 | 5 15 | R. | 21 |
| | S. | 5 56 | 5 57 | 5 58 | 5 58 | 5 59 | 6 00 | 6 01 | 6 01 | 6 03 | 6 04 | 6 05 | 6 06 | 6 07 | 6 08 | 6 10 | 6 11 | 6 13 | 6 15 | 6 17 | 6 20 | 6 23 | 6 26 | 6 30 | 6 35 | 6 41 | S. | |
| 22 | R. | 5 48 | 5 46 | 5 44 | 5 41 | 5 39 | 5 36 | 5 34 | 5 32 | 5 29 | 5 27 | 5 25 | 5 23 | 5 20 | 5 18 | 5 17 | 5 15 | 5 13 | 5 11 | 5 10 | 5 09 | 5 08 | 5 08 | 5 08 | 5 09 | 5 13 | R. | 22 |
| | S. | 5 56 | 5 57 | 5 58 | 5 58 | 5 59 | 6 00 | 6 01 | 6 02 | 6 03 | 6 04 | 6 05 | 6 07 | 6 08 | 6 09 | 6 11 | 6 12 | 6 14 | 6 16 | 6 19 | 6 21 | 6 24 | 6 28 | 6 32 | 6 37 | 6 43 | S. | |
| 23 | R. | 5 48 | 5 46 | 5 44 | 5 41 | 5 39 | 5 36 | 5 34 | 5 31 | 5 29 | 5 27 | 5 24 | 5 22 | 5 19 | 5 17 | 5 15 | 5 14 | 5 12 | 5 10 | 5 08 | 5 07 | 5 06 | 5 06 | 5 06 | 5 07 | 5 11 | R. | 23 |
| | S. | 5 56 | 5 57 | 5 58 | 5 59 | 6 00 | 6 01 | 6 02 | 6 03 | 6 04 | 6 05 | 6 06 | 6 08 | 6 09 | 6 10 | 6 12 | 6 14 | 6 16 | 6 18 | 6 20 | 6 23 | 6 26 | 6 30 | 6 34 | 6 39 | 6 45 | S. | |
| 24 | R. | 5 48 | 5 46 | 5 44 | 5 41 | 5 38 | 5 35 | 5 33 | 5 30 | 5 28 | 5 26 | 5 23 | 5 21 | 5 18 | 5 16 | 5 14 | 5 12 | 5 10 | 5 08 | 5 07 | 5 06 | 5 05 | 5 04 | 5 04 | 5 05 | 5 09 | R. | 24 |
| | S. | 5 56 | 5 57 | 5 58 | 5 59 | 6 00 | 6 01 | 6 02 | 6 03 | 6 04 | 6 06 | 6 07 | 6 09 | 6 10 | 6 11 | 6 13 | 6 15 | 6 17 | 6 19 | 6 22 | 6 25 | 6 28 | 6 31 | 6 36 | 6 41 | 6 47 | S. | |
| 25 | R. | 5 48 | 5 46 | 5 43 | 5 40 | 5 38 | 5 35 | 5 33 | 5 30 | 5 27 | 5 25 | 5 22 | 5 20 | 5 17 | 5 15 | 5 13 | 5 11 | 5 09 | 5 07 | 5 05 | 5 04 | 5 03 | 5 02 | 5 02 | 5 03 | 5 07 | R. | 25 |
| | S. | 5 56 | 5 57 | 5 58 | 5 59 | 6 01 | 6 02 | 6 03 | 6 04 | 6 05 | 6 07 | 6 08 | 6 10 | 6 11 | 6 13 | 6 15 | 6 17 | 6 19 | 6 21 | 6 24 | 6 27 | 6 30 | 6 33 | 6 38 | 6 44 | 6 50 | S. | |
| 26 | R. | 5 48 | 5 45 | 5 43 | 5 40 | 5 38 | 5 35 | 5 32 | 5 29 | 5 27 | 5 24 | 5 21 | 5 19 | 5 16 | 5 14 | 5 12 | 5 10 | 5 07 | 5 05 | 5 03 | 5 02 | 5 01 | 5 00 | 5 00 | 5 01 | 5 05 | R. | 26 |
| | S. | 5 56 | 5 57 | 5 58 | 5 59 | 6 01 | 6 02 | 6 03 | 6 04 | 6 06 | 6 07 | 6 09 | 6 11 | 6 12 | 6 14 | 6 16 | 6 18 | 6 20 | 6 22 | 6 25 | 6 28 | 6 31 | 6 35 | 6 40 | 6 46 | 6 52 | S. | |
| 27 | R. | 5 48 | 5 45 | 5 43 | 5 40 | 5 37 | 5 34 | 5 32 | 5 29 | 5 26 | 5 23 | 5 20 | 5 18 | 5 15 | 5 13 | 5 10 | 5 08 | 5 06 | 5 04 | 5 02 | 5 01 | 4 59 | 4 58 | 4 58 | 4 59 | 5 02 | R. | 27 |
| | S. | 5 57 | 5 58 | 5 59 | 6 00 | 6 01 | 6 02 | 6 04 | 6 05 | 6 07 | 6 08 | 6 10 | 6 12 | 6 13 | 6 15 | 6 17 | 6 19 | 6 22 | 6 24 | 6 27 | 6 30 | 6 33 | 6 37 | 6 42 | 6 48 | 6 54 | S. | |
| 28 | R. | 5 48 | 5 45 | 5 42 | 5 39 | 5 37 | 5 34 | 5 31 | 5 28 | 5 25 | 5 22 | 5 19 | 5 17 | 5 14 | 5 11 | 5 09 | 5 07 | 5 04 | 5 02 | 5 00 | 4 59 | 4 57 | 4 56 | 4 56 | 4 57 | 5 00 | R. | 28 |
| | S. | 5 57 | 5 58 | 5 59 | 6 00 | 6 02 | 6 03 | 6 04 | 6 06 | 6 08 | 6 09 | 6 11 | 6 13 | 6 14 | 6 16 | 6 19 | 6 21 | 6 23 | 6 25 | 6 28 | 6 31 | 6 35 | 6 39 | 6 44 | 6 50 | 6 56 | S. | |
| 29 | R. | 5 48 | 5 45 | 5 42 | 5 39 | 5 36 | 5 33 | 5 30 | 5 27 | 5 24 | 5 21 | 5 18 | 5 16 | 5 13 | 5 10 | 5 07 | 5 05 | 5 03 | 5 00 | 4 58 | 4 57 | 4 55 | 4 54 | 4 53 | 4 54 | 4 58 | R. | 29 |
| | S. | 5 57 | 5 58 | 5 59 | 6 00 | 6 02 | 6 03 | 6 05 | 6 07 | 6 09 | 6 10 | 6 12 | 6 14 | 6 16 | 6 18 | 6 20 | 6 22 | 6 25 | 6 27 | 6 30 | 6 33 | 6 37 | 6 41 | 6 46 | 6 52 | 6 59 | S. | |
| 30 | R. | 5 48 | 5 45 | 5 42 | 5 39 | 5 36 | 5 33 | 5 30 | 5 26 | 5 23 | 5 20 | 5 17 | 5 15 | 5 12 | 5 09 | 5 06 | 5 04 | 5 01 | 4 59 | 4 57 | 4 55 | 4 53 | 4 52 | 4 51 | 4 52 | 4 55 | R. | 30 |
| | S. | 5 57 | 5 58 | 5 59 | 6 01 | 6 02 | 6 04 | 6 06 | 6 07 | 6 09 | 6 11 | 6 13 | 6 15 | 6 17 | 6 19 | 6 21 | 6 24 | 6 26 | 6 29 | 6 32 | 6 35 | 6 39 | 6 43 | 6 48 | 6 55 | 7 01 | S. | |
| 31 | R. | 5 48 | 5 45 | 5 42 | 5 39 | 5 36 | 5 32 | 5 29 | 5 26 | 5 22 | 5 19 | 5 16 | 5 13 | 5 10 | 5 07 | 5 05 | 5 02 | 5 00 | 4 57 | 4 55 | 4 53 | 4 51 | 4 50 | 4 49 | 4 49 | 4 53 | R. | 31 |
| | S. | 5 57 | 5 58 | 6 00 | 6 01 | 6 03 | 6 04 | 6 06 | 6 08 | 6 10 | 6 12 | 6 14 | 6 16 | 6 18 | 6 20 | 6 23 | 6 25 | 6 28 | 6 31 | 6 34 | 6 37 | 6 41 | 6 46 | 6 51 | 6 57 | 7 04 | S. | |
| 32 | R. | 5 48 | 5 44 | 5 41 | 5 38 | 5 35 | 5 32 | 5 29 | 5 25 | 5 22 | 5 18 | 5 15 | 5 12 | 5 09 | 5 06 | 5 03 | 5 01 | 4 58 | 4 55 | 4 53 | 4 51 | 4 49 | 4 48 | 4 46 | 4 47 | 4 50 | R. | 32 |
| | S. | 5 57 | 5 58 | 6 00 | 6 01 | 6 03 | 6 05 | 6 07 | 6 09 | 6 11 | 6 13 | 6 15 | 6 17 | 6 19 | 6 21 | 6 24 | 6 27 | 6 30 | 6 33 | 6 36 | 6 39 | 6 43 | 6 48 | 6 53 | 7 00 | 7 06 | S. | |
| 33 | R. | 5 48 | 5 44 | 5 41 | 5 38 | 5 35 | 5 31 | 5 28 | 5 24 | 5 21 | 5 17 | 5 14 | 5 11 | 5 08 | 5 05 | 5 02 | 4 59 | 4 56 | 4 53 | 4 51 | 4 49 | 4 47 | 4 45 | 4 44 | 4 44 | 4 48 | R. | 33 |
| | S. | 5 57 | 5 58 | 6 00 | 6 02 | 6 04 | 6 06 | 6 08 | 6 10 | 6 12 | 6 14 | 6 16 | 6 18 | 6 21 | 6 23 | 6 26 | 6 28 | 6 31 | 6 34 | 6 38 | 6 42 | 6 46 | 6 50 | 6 56 | 7 02 | 7 09 | S. | |
| 34 | R. | 5 48 | 5 44 | 5 41 | 5 37 | 5 34 | 5 30 | 5 27 | 5 23 | 5 20 | 5 16 | 5 13 | 5 10 | 5 07 | 5 03 | 5 00 | 4 57 | 4 54 | 4 51 | 4 49 | 4 47 | 4 45 | 4 43 | 4 41 | 4 42 | 4 45 | R. | 34 |
| | S. | 5 57 | 5 58 | 6 00 | 6 02 | 6 04 | 6 06 | 6 08 | 6 10 | 6 12 | 6 15 | 6 17 | 6 19 | 6 22 | 6 24 | 6 27 | 6 30 | 6 33 | 6 36 | 6 40 | 6 44 | 6 48 | 6 53 | 6 58 | 7 04 | 7 11 | S. | |
| 35 | R. | 5 48 | 5 44 | 5 41 | 5 37 | 5 34 | 5 30 | 5 26 | 5 23 | 5 19 | 5 15 | 5 12 | 5 09 | 5 05 | 5 02 | 4 59 | 4 56 | 4 53 | 4 50 | 4 47 | 4 45 | 4 42 | 4 40 | 4 39 | 4 39 | 4 42 | R. | 35 |
| | S. | 5 57 | 5 58 | 6 01 | 6 03 | 6 05 | 6 07 | 6 09 | 6 11 | 6 13 | 6 16 | 6 18 | 6 21 | 6 23 | 6 26 | 6 29 | 6 32 | 6 35 | 6 38 | 6 42 | 6 46 | 6 50 | 6 55 | 7 01 | 7 07 | 7 14 | S. | |
| 36 | R. | 5 48 | 5 44 | 5 41 | 5 37 | 5 33 | 5 29 | 5 26 | 5 22 | 5 18 | 5 14 | 5 11 | 5 08 | 5 04 | 5 00 | 4 57 | 4 54 | 4 51 | 4 48 | 4 45 | 4 42 | 4 40 | 4 38 | 4 36 | 4 36 | 4 39 | R. | 36 |
| | S. | 5 57 | 5 59 | 6 01 | 6 03 | 6 05 | 6 07 | 6 10 | 6 12 | 6 14 | 6 17 | 6 19 | 6 22 | 6 25 | 6 27 | 6 30 | 6 33 | 6 37 | 6 40 | 6 44 | 6 48 | 6 53 | 6 58 | 7 03 | 7 10 | 7 17 | S. | |
| 37 | R. | 5 48 | 5 44 | 5 40 | 5 36 | 5 33 | 5 28 | 5 25 | 5 21 | 5 17 | 5 13 | 5 10 | 5 06 | 5 02 | 4 59 | 4 55 | 4 52 | 4 49 | 4 46 | 4 43 | 4 40 | 4 37 | 4 35 | 4 34 | 4 33 | 4 36 | R. | 37 |
| | S. | 5 57 | 5 59 | 6 01 | 6 03 | 6 06 | 6 08 | 6 11 | 6 13 | 6 15 | 6 18 | 6 21 | 6 23 | 6 26 | 6 29 | 6 32 | 6 35 | 6 39 | 6 42 | 6 46 | 6 51 | 6 55 | 7 00 | 7 06 | 7 13 | 7 20 | S. | |
| 38 | R. | 5 47 | 5 44 | 5 40 | 5 36 | 5 32 | 5 28 | 5 24 | 5 20 | 5 16 | 5 12 | 5 09 | 5 05 | 5 01 | 4 57 | 4 54 | 4 50 | 4 47 | 4 44 | 4 41 | 4 38 | 4 35 | 4 33 | 4 31 | 4 30 | 4 33 | R. | 38 |
| | S. | 5 57 | 5 59 | 6 02 | 6 04 | 6 06 | 6 09 | 6 11 | 6 13 | 6 16 | 6 19 | 6 22 | 6 25 | 6 28 | 6 31 | 6 34 | 6 37 | 6 41 | 6 44 | 6 48 | 6 53 | 6 58 | 7 03 | 7 09 | 7 16 | 7 23 | S. | |
| 39 | R. | 5 47 | 5 43 | 5 39 | 5 35 | 5 31 | 5 27 | 5 23 | 5 19 | 5 15 | 5 11 | 5 07 | 5 03 | 4 59 | 4 55 | 4 52 | 4 48 | 4 45 | 4 41 | 4 38 | 4 35 | 4 32 | 4 30 | 4 28 | 4 27 | 4 30 | R. | 39 |
| | S. | 5 57 | 5 59 | 6 02 | 6 04 | 6 07 | 6 09 | 6 12 | 6 14 | 6 17 | 6 20 | 6 23 | 6 26 | 6 29 | 6 32 | 6 36 | 6 39 | 6 43 | 6 47 | 6 51 | 6 55 | 7 00 | 7 06 | 7 12 | 7 19 | 7 26 | S. | |
| 40 | R. | 5 47 | 5 43 | 5 39 | 5 35 | 5 31 | 5 27 | 5 23 | 5 18 | 5 14 | 5 10 | 5 06 | 5 02 | 4 58 | 4 54 | 4 50 | 4 47 | 4 43 | 4 39 | 4 36 | 4 33 | 4 30 | 4 27 | 4 25 | 4 24 | 4 27 | R. | 40 |
| | S. | 5 57 | 5 59 | 6 02 | 6 05 | 6 07 | 6 10 | 6 13 | 6 15 | 6 18 | 6 21 | 6 24 | 6 27 | 6 31 | 6 34 | 6 37 | 6 41 | 6 45 | 6 49 | 6 53 | 6 58 | 7 03 | 7 09 | 7 15 | 7 22 | 7 29 | S. | |

## Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°.—September 23 to December 22.

[R=Local mean time of sun's visible rising.  S=Local mean time of sun's visible setting.]

| Approx. date | Dec. S. | 41 R. | 41 S. | 42 R. | 42 S. | 43 R. | 43 S. | 44 R. | 44 S. | 45 R. | 45 S. | 46 R. | 46 S. | 47 R. | 47 S. | 48 R. | 48 S. | 49 R. | 49 S. | 50 R. | 50 S. | 51 R. | 51 S. | 52 R. | 52 S. | 53 R. | 53 S. | 54 R. | 54 S. | 55 R. | 55 S. | 56 R. | 56 S. | 57 R. | 57 S. | 58 R. | 58 S. | 59 R. | 59 S. | 60 R. | 60 S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

*DECEMBER, NOVEMBER, OCTOBER, SEPTEMBER — data columns by approximate date and declination (Dec. 22 through Sept. 23).*

# TABLE 10.

## Mean Time of Sun's Visible Rising and Setting.

South Latitude: 0° to 20°—December 22 to March 21.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

| Lat. S. | | | 0° | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

*(Table 10 — dense numerical grid of local mean times of the sun's visible rising (R) and setting (S) for South Latitudes 0° to 20°, tabulated by approximate date from December 22 through March 21, with corresponding solar declination values. The full grid of hour–minute entries is not reproduced here.)*

## South Latitude: 21° to 40°—December 22 to March 21.

[R=Local mean time of sun's visible rising. S=Local mean time of sun's visible setting.]

| Lat. S. | Approx. date. | DECEMBER. | JANUARY. | | | | | | FEBRUARY. | | | | | | | | | MARCH. | | | | | | | | | Approx. date. | Lat. S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 22 | 2 | 10 | 16 | 21 | 25 | 29 | 2 | 5 | 9 | 12 | 15 | 18 | 20 | 23 | 26 | 1 | 3 | 6 | 8 | 11 | 13 | 16 | 18 | 21 | | |
| | Dec. S. | 23° 27′ | 23° | 22° | 21° | 20° | 19° | 18° | 17° | 16° | 15° | 14° | 13° | 12° | 11° | 10° | 9° | 8° | 7° | 6° | 5° | 4° | 3° | 2° | 1° | 0° | Dec. S. | |
| ° | | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. | | ° |
| 21 | R. | 5 15 | 5 22 | 5 28 | 5 32 | 5 35 | 5 38 | 5 41 | 5 43 | 5 45 | 5 47 | 5 48 | 5 50 | 5 51 | 5 53 | 5 54 | 5 55 | 5 56 | 5 58 | 5 59 | 6 00 | 6 00 | 6 01 | 6 02 | 6 03 | 6 03 | R. | 21 |
| | S. | 6 41 | 6 46 | 6 48 | 6 48 | 6 48 | 6 47 | 6 46 | 6 45 | 6 44 | 6 42 | 6 40 | 6 39 | 6 37 | 6 35 | 6 33 | 6 31 | 6 29 | 6 27 | 6 25 | 6 23 | 6 20 | 6 18 | 6 16 | 6 14 | 6 11 | S. | |
| 22 | R. | 5 13 | 5 20 | 5 26 | 5 30 | 5 33 | 5 36 | 5 39 | 5 41 | 5 44 | 5 46 | 5 47 | 5 49 | 5 50 | 5 52 | 5 53 | 5 54 | 5 56 | 5 57 | 5 58 | 6 00 | 6 00 | 6 01 | 6 02 | 6 03 | 6 03 | R. | 22 |
| | S. | 6 43 | 6 48 | 6 50 | 6 50 | 6 49 | 6 48 | 6 47 | 6 46 | 6 45 | 6 43 | 6 41 | 6 40 | 6 38 | 6 36 | 6 34 | 6 32 | 6 30 | 6 27 | 6 25 | 6 23 | 6 20 | 6 18 | 6 16 | 6 14 | 6 11 | S. | |
| 23 | R. | 5 11 | 5 18 | 5 24 | 5 28 | 5 31 | 5 34 | 5 37 | 5 40 | 5 42 | 5 44 | 5 46 | 5 48 | 5 49 | 5 51 | 5 53 | 5 54 | 5 55 | 5 57 | 5 58 | 5 59 | 6 00 | 6 01 | 6 02 | 6 03 | 6 03 | R. | 23 |
| | S. | 6 45 | 6 50 | 6 52 | 6 52 | 6 51 | 6 50 | 6 49 | 6 48 | 6 46 | 6 44 | 6 43 | 6 41 | 6 39 | 6 37 | 6 35 | 6 33 | 6 30 | 6 28 | 6 26 | 6 23 | 6 21 | 6 19 | 6 16 | 6 14 | 6 11 | S. | |
| 24 | R. | 5 09 | 5 16 | 5 22 | 5 26 | 5 30 | 5 33 | 5 36 | 5 38 | 5 41 | 5 43 | 5 45 | 5 47 | 5 48 | 5 50 | 5 52 | 5 53 | 5 55 | 5 56 | 5 57 | 5 59 | 6 00 | 6 01 | 6 02 | 6 03 | 6 03 | R. | 24 |
| | S. | 6 47 | 6 52 | 6 54 | 6 53 | 6 53 | 6 52 | 6 51 | 6 49 | 6 48 | 6 46 | 6 44 | 6 42 | 6 40 | 6 38 | 6 36 | 6 33 | 6 31 | 6 28 | 6 26 | 6 24 | 6 21 | 6 19 | 6 16 | 6 14 | 6 11 | S. | |
| 25 | R. | 5 07 | 5 14 | 5 20 | 5 24 | 5 28 | 5 31 | 5 34 | 5 37 | 5 39 | 5 41 | 5 43 | 5 45 | 5 47 | 5 49 | 5 51 | 5 52 | 5 54 | 5 55 | 5 57 | 5 58 | 5 59 | 6 00 | 6 01 | 6 02 | 6 03 | R. | 25 |
| | S. | 6 50 | 6 54 | 6 56 | 6 55 | 6 55 | 6 54 | 6 53 | 6 51 | 6 49 | 6 47 | 6 45 | 6 43 | 6 41 | 6 39 | 6 37 | 6 34 | 6 32 | 6 29 | 6 27 | 6 24 | 6 21 | 6 19 | 6 16 | 6 14 | 6 11 | S. | |
| 26 | R. | 5 05 | 5 12 | 5 18 | 5 22 | 5 26 | 5 29 | 5 32 | 5 35 | 5 38 | 5 40 | 5 42 | 5 44 | 5 46 | 5 48 | 5 50 | 5 51 | 5 53 | 5 55 | 5 56 | 5 58 | 5 59 | 6 00 | 6 01 | 6 02 | 6 03 | R. | 26 |
| | S. | 6 52 | 6 56 | 6 58 | 6 57 | 6 56 | 6 55 | 6 54 | 6 52 | 6 51 | 6 48 | 6 46 | 6 44 | 6 42 | 6 40 | 6 38 | 6 35 | 6 32 | 6 30 | 6 27 | 6 25 | 6 22 | 6 19 | 6 16 | 6 14 | 6 11 | S. | |
| 27 | R. | 5 02 | 5 09 | 5 16 | 5 20 | 5 24 | 5 28 | 5 31 | 5 34 | 5 36 | 5 39 | 5 41 | 5 43 | 5 45 | 5 47 | 5 49 | 5 50 | 5 52 | 5 54 | 5 56 | 5 57 | 5 58 | 6 00 | 6 01 | 6 02 | 6 03 | R. | 27 |
| | S. | 6 54 | 6 58 | 7 00 | 6 59 | 6 58 | 6 57 | 6 56 | 6 54 | 6 52 | 6 50 | 6 48 | 6 45 | 6 43 | 6 41 | 6 39 | 6 36 | 6 33 | 6 30 | 6 28 | 6 25 | 6 22 | 6 20 | 6 17 | 6 14 | 6 11 | S. | |
| 28 | R. | 5 00 | 5 07 | 5 14 | 5 18 | 5 22 | 5 26 | 5 29 | 5 32 | 5 35 | 5 37 | 5 39 | 5 42 | 5 44 | 5 46 | 5 48 | 5 49 | 5 51 | 5 53 | 5 55 | 5 57 | 5 58 | 5 59 | 6 00 | 6 02 | 6 03 | R. | 28 |
| | S. | 6 56 | 7 00 | 7 02 | 7 01 | 7 00 | 6 59 | 6 57 | 6 55 | 6 53 | 6 51 | 6 49 | 6 47 | 6 44 | 6 42 | 6 40 | 6 37 | 6 34 | 6 31 | 6 28 | 6 26 | 6 23 | 6 20 | 6 17 | 6 14 | 6 11 | S. | |
| 29 | R. | 4 58 | 5 05 | 5 11 | 5 16 | 5 20 | 5 24 | 5 27 | 5 30 | 5 33 | 5 36 | 5 38 | 5 40 | 5 43 | 5 45 | 5 47 | 5 48 | 5 50 | 5 52 | 5 54 | 5 56 | 5 58 | 5 59 | 6 00 | 6 02 | 6 03 | R. | 29 |
| | S. | 6 59 | 7 03 | 7 04 | 7 03 | 7 02 | 7 01 | 6 59 | 6 57 | 6 55 | 6 53 | 6 51 | 6 48 | 6 46 | 6 43 | 6 41 | 6 38 | 6 35 | 6 32 | 6 29 | 6 26 | 6 23 | 6 20 | 6 17 | 6 14 | 6 11 | S. | |
| 30 | R. | 4 55 | 5 02 | 5 09 | 5 14 | 5 18 | 5 22 | 5 26 | 5 29 | 5 32 | 5 34 | 5 37 | 5 39 | 5 42 | 5 44 | 5 46 | 5 48 | 5 50 | 5 52 | 5 54 | 5 56 | 5 57 | 5 59 | 6 00 | 6 02 | 6 03 | R. | 30 |
| | S. | 7 01 | 7 05 | 7 06 | 7 05 | 7 04 | 7 02 | 7 01 | 6 59 | 6 57 | 6 54 | 6 52 | 6 49 | 6 47 | 6 44 | 6 42 | 6 39 | 6 36 | 6 33 | 6 30 | 6 27 | 6 23 | 6 21 | 6 18 | 6 15 | 6 12 | S. | |
| 31 | R. | 4 53 | 5 00 | 5 07 | 5 12 | 5 16 | 5 20 | 5 24 | 5 27 | 5 30 | 5 33 | 5 35 | 5 38 | 5 40 | 5 42 | 5 45 | 5 47 | 5 49 | 5 51 | 5 53 | 5 55 | 5 57 | 5 58 | 6 00 | 6 02 | 6 03 | R. | 31 |
| | S. | 7 04 | 7 08 | 7 09 | 7 08 | 7 06 | 7 04 | 7 03 | 7 01 | 6 58 | 6 56 | 6 53 | 6 51 | 6 48 | 6 45 | 6 43 | 6 40 | 6 37 | 6 33 | 6 30 | 6 27 | 6 24 | 6 21 | 6 18 | 6 15 | 6 12 | S. | |
| 32 | R. | 4 50 | 4 57 | 5 04 | 5 10 | 5 14 | 5 18 | 5 22 | 5 25 | 5 28 | 5 31 | 5 34 | 5 37 | 5 39 | 5 41 | 5 44 | 5 46 | 5 48 | 5 51 | 5 53 | 5 55 | 5 56 | 5 58 | 5 59 | 6 01 | 6 03 | R. | 32 |
| | S. | 7 06 | 7 10 | 7 11 | 7 10 | 7 08 | 7 06 | 7 05 | 7 03 | 7 00 | 6 57 | 6 55 | 6 52 | 6 49 | 6 46 | 6 44 | 6 41 | 6 37 | 6 34 | 6 31 | 6 28 | 6 24 | 6 21 | 6 18 | 6 15 | 6 12 | S. | |
| 33 | R. | 4 48 | 4 55 | 5 02 | 5 07 | 5 12 | 5 16 | 5 20 | 5 23 | 5 27 | 5 30 | 5 32 | 5 35 | 5 38 | 5 40 | 5 54 | 5 45 | 5 47 | 5 50 | 5 52 | 5 54 | 5 56 | 5 58 | 5 59 | 6 01 | 6 03 | R. | 33 |
| | S. | 7 09 | 7 13 | 7 14 | 7 12 | 7 11 | 7 09 | 7 07 | 7 04 | 7 02 | 6 59 | 6 56 | 6 53 | 6 50 | 6 47 | 6 45 | 6 42 | 6 38 | 6 35 | 6 32 | 6 29 | 6 25 | 6 22 | 6 18 | 6 15 | 6 12 | S. | |
| 34 | R. | 4 45 | 4 52 | 4 59 | 5 05 | 5 10 | 5 14 | 5 18 | 5 21 | 5 25 | 5 28 | 5 31 | 5 34 | 5 37 | 5 39 | 5 42 | 5 44 | 5 47 | 5 49 | 5 51 | 5 53 | 5 55 | 5 57 | 5 59 | 6 01 | 6 03 | R. | 34 |
| | S. | 7 11 | 7 15 | 7 16 | 7 15 | 7 13 | 7 11 | 7 09 | 7 06 | 7 03 | 7 00 | 6 58 | 6 55 | 6 52 | 6 49 | 6 46 | 6 43 | 6 39 | 6 35 | 6 32 | 6 29 | 6 25 | 6 22 | 6 18 | 6 15 | 6 12 | S. | |
| 35 | R. | 4 42 | 4 50 | 4 57 | 5 02 | 5 07 | 5 12 | 5 16 | 5 19 | 5 23 | 5 26 | 5 29 | 5 32 | 5 35 | 5 38 | 5 41 | 5 43 | 5 46 | 5 48 | 5 50 | 5 53 | 5 55 | 5 57 | 5 59 | 6 01 | 6 03 | R. | 35 |
| | S. | 7 14 | 7 18 | 7 19 | 7 17 | 7 15 | 7 13 | 7 11 | 7 08 | 7 05 | 7 02 | 6 59 | 6 56 | 6 53 | 6 50 | 6 47 | 6 44 | 6 40 | 6 36 | 6 33 | 6 30 | 6 26 | 6 23 | 6 19 | 6 15 | 6 12 | S. | |
| 36 | R. | 4 39 | 4 47 | 4 54 | 5 00 | 5 05 | 5 09 | 5 14 | 5 17 | 5 21 | 5 25 | 5 28 | 5 31 | 5 34 | 5 37 | 5 40 | 5 42 | 5 45 | 5 47 | 5 50 | 5 52 | 5 54 | 5 57 | 5 59 | 6 01 | 6 03 | R. | 36 |
| | S. | 7 17 | 7 21 | 7 21 | 7 20 | 7 18 | 7 15 | 7 13 | 7 10 | 7 07 | 7 04 | 7 01 | 6 58 | 6 55 | 6 51 | 6 48 | 6 45 | 6 41 | 6 37 | 6 34 | 6 30 | 6 26 | 6 23 | 6 19 | 6 15 | 6 12 | S. | |
| 37 | R. | 4 36 | 4 44 | 4 52 | 4 57 | 5 02 | 5 07 | 5 11 | 5 15 | 5 19 | 5 23 | 5 26 | 5 29 | 5 32 | 5 35 | 5 38 | 5 41 | 5 44 | 5 46 | 5 49 | 5 51 | 5 54 | 5 56 | 5 58 | 6 01 | 6 03 | R. | 37 |
| | S. | 7 20 | 7 24 | 7 24 | 7 22 | 7 20 | 7 18 | 7 15 | 7 12 | 7 09 | 7 06 | 7 03 | 6 59 | 6 56 | 6 52 | 6 49 | 6 46 | 6 42 | 6 38 | 6 35 | 6 31 | 6 27 | 6 23 | 6 19 | 6 16 | 6 12 | S. | |
| 38 | R. | 4 33 | 4 41 | 4 49 | 4 55 | 5 00 | 5 05 | 5 09 | 5 13 | 5 17 | 5 21 | 5 24 | 5 28 | 5 31 | 5 34 | 5 37 | 5 40 | 5 43 | 5 46 | 5 48 | 5 51 | 5 53 | 5 56 | 5 58 | 6 00 | 6 02 | R. | 38 |
| | S. | 7 23 | 7 27 | 7 27 | 7 25 | 7 23 | 7 20 | 7 17 | 7 14 | 7 11 | 7 08 | 7 04 | 7 01 | 6 58 | 6 54 | 6 50 | 6 47 | 6 43 | 6 39 | 6 35 | 6 32 | 6 28 | 6 24 | 6 20 | 6 16 | 6 12 | S. | |
| 39 | R. | 4 30 | 4 38 | 4 46 | 4 52 | 4 57 | 5 02 | 5 07 | 5 11 | 5 15 | 5 19 | 5 22 | 5 26 | 5 29 | 5 32 | 5 36 | 5 39 | 5 42 | 5 45 | 5 47 | 5 50 | 5 52 | 5 55 | 5 58 | 6 00 | 6 02 | R. | 39 |
| | S. | 7 26 | 7 30 | 7 30 | 7 28 | 7 25 | 7 22 | 7 19 | 7 16 | 7 13 | 7 10 | 7 06 | 7 03 | 6 59 | 6 55 | 6 52 | 6 48 | 6 44 | 6 40 | 6 36 | 6 32 | 6 28 | 6 24 | 6 20 | 6 16 | 6 12 | S. | |
| 40 | R. | 4 27 | 4 35 | 4 43 | 4 49 | 4 55 | 5 00 | 5 05 | 5 09 | 5 13 | 5 17 | 5 21 | 5 24 | 5 28 | 5 31 | 5 35 | 5 38 | 5 41 | 5 44 | 5 47 | 5 50 | 5 52 | 5 55 | 5 57 | 6 00 | 6 02 | R. | 40 |
| | S. | 7 29 | 7 33 | 7 33 | 7 30 | 7 28 | 7 25 | 7 22 | 7 18 | 7 15 | 7 11 | 7 08 | 7 04 | 7 01 | 6 57 | 6 53 | 6 49 | 6 45 | 6 41 | 6 37 | 6 33 | 6 28 | 6 25 | 6 20 | 6 16 | 6 12 | S. | |

# TABLE 10.

### Mean Time of Sun's Visible Rising and Setting.

South Latitude: 41° to 60°—December 22 to March 21.

[R=Local mean time of sun's visible rising.   S=Local mean time of sun's visible setting.]

| Lat. S. | Approx. date. | Dec. S. | 41 R. | 41 S. | 42 R. | 42 S. | 43 R. | 43 S. | 44 R. | 44 S. | 45 R. | 45 S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

*(Table 10 continues as an extensive numerical grid of rising and setting times for South Latitudes 41° to 60°, spanning columns for each latitude with R and S values, across approximate dates from December 22 to March 21 — MARCH, FEBRUARY, JANUARY, DECEMBER.)*

MARCH.

FEBRUARY.

JANUARY.

DECEMBER.

TABLE 11.     [Page 509

For reducing the Time of the Moon's passage over the Meridian of Greenwich to the Time of its passage over any other Meridian.   The numbers taken from this Table are to be added to the Time at Greenwich in West Longitude, subtracted in East Longitude.

| Longitude. | Daily variation of the moon's passing the meridian. | | | | | | | | | | | | | | Longitude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40m | 42m | 44m | 46m | 48m | 50m | 52m | 54m | 56m | 58m | 60m | 62m | 64m | 66m | |
| ° | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | m. | ° |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 |
| 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 10 |
| 15 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 15 |
| 20 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 20 |
| 25 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 25 |
| 30 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 30 |
| 35 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 35 |
| 40 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 40 |
| 45 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 45 |
| 50 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 50 |
| 55 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 | 55 |
| 60 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 60 |
| 65 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 65 |
| 70 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 70 |
| 75 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 14 | 75 |
| 80 | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 80 |
| 85 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 85 |
| 90 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 90 |
| 95 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 17 | 95 |
| 100 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 100 |
| 105 | 12 | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 17 | 18 | 19 | 19 | 105 |
| 110 | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 110 |
| 115 | 13 | 13 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 20 | 21 | 115 |
| 120 | 13 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 120 |
| 125 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 22 | 23 | 125 |
| 130 | 14 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 130 |
| 135 | 15 | 16 | 16 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 135 |
| 140 | 16 | 16 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 140 |
| 145 | 16 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27 | 145 |
| 150 | 17 | 17 | 18 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 150 |
| 155 | 17 | 18 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 28 | 155 |
| 160 | 18 | 19 | 20 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 28 | 29 | 160 |
| 165 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 165 |
| 170 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 170 |
| 175 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 175 |
| 180 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 180 |
| | 40m | 42m | 44m | 46m | 48m | 50m | 52m | 54m | 56m | 58m | 60m | 62m | 64m | 66m | |

# TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | 1″ | 2″ | 3″ | 4″ | 5″ | 6″ | 7″ | 8″ | 9″ | 10″ | 11″ | 12″ | 13″ | 14″ | 15″ | 16″ | 17″ | 18″ | 19″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 5 |
| 6 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 6 |
| 7 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 7 |
| 8 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 8 |
| 9 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 9 |
| 10 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 10 |
| 11 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 11 |
| 12 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 12 |
| 13 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 13 |
| 14 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 14 |
| 15 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 5 | 15 |
| 16 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 16 |
| 17 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 17 |
| 18 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 18 |
| 19 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 19 |
| 20 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 20 |
| 21 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 21 |
| 22 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 22 |
| 23 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 23 |
| 24 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 24 |
| 25 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 25 |
| 26 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 26 |
| 27 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 27 |
| 28 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 28 |
| 29 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 29 |
| 30 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 30 |
| 31 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 31 |
| 32 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 10 | 32 |
| 33 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 33 |
| 34 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 10 | 11 | 34 |
| 35 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 11 | 35 |
| 36 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 8 | 9 | 10 | 10 | 11 | 11 | 36 |
| 37 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 10 | 11 | 12 | 37 |
| 38 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 10 | 11 | 11 | 12 | 38 |
| 39 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 8 | 9 | 10 | 10 | 11 | 12 | 12 | 39 |
| 40 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 11 | 12 | 13 | 40 |
| 41 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 10 | 11 | 12 | 12 | 13 | 41 |
| 42 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 13 | 42 |
| 43 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 43 |
| 44 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 10 | 11 | 12 | 12 | 13 | 14 | 44 |
| 45 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 14 | 45 |
| 46 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 12 | 13 | 14 | 15 | 46 |
| 47 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 13 | 14 | 15 | 47 |
| 48 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 14 | 15 | 48 |
| 49 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 16 | 49 |
| 50 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 13 | 14 | 15 | 16 | 50 |
| 51 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 14 | 14 | 15 | 16 | 51 |
| 52 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 16 | 52 |
| 53 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 53 |
| 54 | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14 | 15 | 16 | 17 | 54 |
| 55 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 17 | 55 |
| 56 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 56 |
| 57 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 57 |
| 58 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 15 | 16 | 17 | 18 | 58 |
| 59 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 59 |
| 60 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 60 |

TABLE 12. [Page 511

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | 20″ | 21″ | 22″ | 23″ | 24″ | 25″ | 26″ | 27″ | 28″ | 29″ | 30″ | 31″ | 32″ | 33″ | 34″ | 35″ | 36″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| 4 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 |
| 5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 5 |
| 6 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 6 |
| 7 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 7 |
| 8 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 8 |
| 9 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 9 |
| 10 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 10 |
| 11 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 11 |
| 12 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 12 |
| 13 | 4 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 13 |
| 14 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 14 |
| 15 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 15 |
| 16 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 16 |
| 17 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 17 |
| 18 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 18 |
| 19 | 6 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 19 |
| 20 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 20 |
| 21 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 12 | 13 | 21 |
| 22 | 7 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 22 |
| 23 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 13 | 14 | 23 |
| 24 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 14 | 14 | 14 | 24 |
| 25 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 15 | 15 | 25 |
| 26 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 26 |
| 27 | 9 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 27 |
| 28 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 28 |
| 29 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 17 | 17 | 29 |
| 30 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 30 |
| 31 | 10 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 31 |
| 32 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 32 |
| 33 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 33 |
| 34 | 11 | 12 | 12 | 13 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 34 |
| 35 | 12 | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 35 |
| 36 | 12 | 13 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 20 | 21 | 22 | 36 |
| 37 | 12 | 13 | 14 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 20 | 21 | 22 | 22 | 37 |
| 38 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 38 |
| 39 | 13 | 14 | 14 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 21 | 22 | 23 | 23 | 39 |
| 40 | 13 | 14 | 15 | 15 | 16 | 17 | 17 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 40 |
| 41 | 14 | 14 | 15 | 16 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 25 | 41 |
| 42 | 14 | 15 | 15 | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 25 | 42 |
| 43 | 14 | 15 | 16 | 16 | 17 | 18 | 19 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 43 |
| 44 | 15 | 15 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 26 | 44 |
| 45 | 15 | 16 | 17 | 17 | 18 | 19 | 20 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 26 | 27 | 45 |
| 46 | 15 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 25 | 25 | 26 | 27 | 28 | 46 |
| 47 | 16 | 16 | 17 | 18 | 19 | 20 | 20 | 21 | 22 | 23 | 24 | 24 | 25 | 26 | 27 | 27 | 28 | 47 |
| 48 | 16 | 17 | 18 | 18 | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 29 | 48 |
| 49 | 16 | 17 | 18 | 19 | 20 | 20 | 21 | 22 | 23 | 24 | 25 | 25 | 26 | 27 | 28 | 29 | 29 | 49 |
| 50 | 17 | 18 | 18 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27 | 28 | 28 | 29 | 30 | 50 |
| 51 | 17 | 18 | 19 | 20 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 29 | 30 | 31 | 51 |
| 52 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 29 | 30 | 31 | 52 |
| 53 | 18 | 19 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 27 | 28 | 29 | 30 | 31 | 32 | 53 |
| 54 | 18 | 19 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 27. | 28 | 29 | 30 | 31 | 32 | 32 | 54 |
| 55 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 28 | 29 | 30 | 31 | 32 | 33 | 55 |
| 56 | 19 | 20 | 21 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 56 |
| 57 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 33 | 34 | 57 |
| 58 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 58 |
| 59 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 30 | 31 | 32 | 33 | 34 | 35 | 59 |
| 60 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29· | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 60 |

# TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | 37″ | 38″ | 39″ | 40″ | 41″ | 42″ | 43″ | 44″ | 45″ | 46″ | 47″ | 48″ | 49″ | 50″ | 51″ | 52″ | 53″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 |
| 5 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 |
| 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 |
| 7 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 7 |
| 8 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 |
| 9 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 |
| 10 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 10 |
| 11 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 11 |
| 12 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 11 | 12 |
| 13 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 13 |
| 14 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 14 |
| 15 | 9 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 15 |
| 16 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 16 |
| 17 | 10 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 15 | 15 | 17 |
| 18 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 18 |
| 19 | 12 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 17 | 19 |
| 20 | 12 | 13 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 17 | 18 | 20 |
| 21 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 18 | 18 | 18 | 19 | 21 |
| 22 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 17 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 22 |
| 23 | 14 | 15 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 20 | 20 | 20 | 23 |
| 24 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 24 |
| 25 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 25 |
| 26 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 26 |
| 27 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 23 | 24 | 27 |
| 28 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 28 |
| 29 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 29 |
| 30 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 30 |
| 31 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 31 |
| 32 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 32 |
| 33 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 29 | 33 |
| 34 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 34 |
| 35 | 22 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 30 | 31 | 35 |
| 36 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 36 |
| 37 | 23 | 23 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 30 | 30 | 31 | 31 | 32 | 33 | 37 |
| 38 | 23 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 34 | 38 |
| 39 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 34 | 39 |
| 40 | 25 | 25 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 35 | 35 | 40 |
| 41 | 25 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 35 | 36 | 36 | 41 |
| 42 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 36 | 36 | 37 | 42 |
| 43 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 36 | 37 | 37 | 38 | 43 |
| 44 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 36 | 37 | 37 | 38 | 39 | 44 |
| 45 | 28 | 29 | 29 | 30 | 31 | 32 | 32 | 33 | 34 | 35 | 35 | 36 | 37 | 38 | 38 | 39 | 40 | 45 |
| 46 | 28 | 29 | 30 | 31 | 31 | 32 | 33 | 34 | 35 | 35 | 36 | 37 | 38 | 38 | 39 | 40 | 41 | 46 |
| 47 | 29 | 30 | 31 | 31 | 32 | 33 | 34 | 34 | 35 | 36 | 37 | 38 | 38 | 39 | 40 | 41 | 42 | 47 |
| 48 | 30 | 30 | 31 | 32 | 33 | 34 | 34 | 35 | 36 | 37 | 38 | 38 | 39 | 40 | 41 | 42 | 42 | 48 |
| 49 | 30 | 31 | 32 | 33 | 33 | 34 | 35 | 36 | 37 | 38 | 38 | 39 | 40 | 41 | 42 | 42 | 43 | 49 |
| 50 | 31 | 32 | 33 | 33 | 34 | 35 | 36 | 37 | 38 | 38 | 39 | 40 | 41 | 42 | 43 | 43 | 44 | 50 |
| 51 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 43 | 44 | 45 | 51 |
| 52 | 32 | 33 | 34 | 35 | 36 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 42 | 43 | 44 | 45 | 46 | 52 |
| 53 | 33 | 34 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 42 | 43 | 44 | 45 | 46 | 47 | 53 |
| 54 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 54 |
| 55 | 34 | 35 | 36 | 37 | 38 | 39 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 55 |
| 56 | 35 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 49 | 56 |
| 57 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 48 | 49 | 50 | 57 |
| 58 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 58 |
| 59 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 59 |
| 60 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 60 |

TABLE 12. [Page 513

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | 54″ | 55″ | 56″ | 57″ | 58″ | 59″ | 60″ | 61″ | 62″ | 63″ | 64″ | 65″ | 66″ | 67″ | 68″ | 69″ | 70″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | Horary motion. | | | | | |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 3 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 4 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 5 |
| 6 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 6 |
| 7 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 7 |
| 8 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 8 |
| 9 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 9 |
| 10 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 10 |
| 11 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 11 |
| 12 | 11 | 11 | 11 | 11 | 12° | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 12 |
| 13 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 13 |
| 14 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 14 |
| 15 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 18 | 15 |
| 16 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 19 | 16 |
| 17 | 15 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 17 |
| 18 | 16 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 20 | 21 | 21 | 18 |
| 19 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 19 |
| 20 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 20 |
| 21 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 21 |
| 22 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 22 |
| 23 | 21 | 21 | 21 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 26 | 27 | 23 |
| 24 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 28 | 28 | 24 |
| 25 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 25 |
| 26 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | 26 |
| 27 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 27 |
| 28 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 28 |
| 29 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 29 |
| 30 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 30 |
| 31 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 31 |
| 32 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 37 | 37 | 32 |
| 33 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 37 | 37 | 38 | 39 | 33 |
| 34 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 35 | 35 | 36 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 34 |
| 35 | 32 | 32 | 33 | 33 | 34 | 34 | 35 | 36 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 40 | 41 | 35 |
| 36 | 32 | 33 | 34 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 38 | 39 | 40 | 40 | 41 | 41 | 42 | 36 |
| 37 | 33 | 34 | 35 | 35 | 36 | 36 | 37 | 38 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 43 | 43 | 37 |
| 38 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 42 | 43 | 44 | 44 | 38 |
| 39 | 35 | 36 | 36 | 37 | 38 | 38 | 39 | 40 | 40 | 41 | 42 | 42 | 43 | 44 | 44 | 45 | 46 | 39 |
| 40 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 43 | 43 | 44 | 45 | 45 | 46 | 47 | 40 |
| 41 | 37 | 38 | 38 | 39 | 40 | 40 | 41 | 42 | 42 | 43 | 44 | 44 | 45 | 46 | 46 | 47 | 48 | 41 |
| 42 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 43 | 43 | 44 | 45 | 46 | 46 | 47 | 48 | 48 | 49 | 42 |
| 43 | 39 | 39 | 40 | 41 | 42 | 42 | 43 | 44 | 44 | 45 | 46 | 46 | 47 | 48 | 49 | 49 | 50 | 43 |
| 44 | 40 | 40 | 41 | 42 | 43 | 43 | 44 | 45 | 45 | 46 | 47 | 48 | 48 | 49 | 50 | 51 | 51 | 44 |
| 45 | 41 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 | 47 | 48 | 49 | 50 | 50 | 51 | 52 | 53 | 45 |
| 46 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 | 48 | 48 | 49 | 50 | 51 | 51 | 52 | 53 | 54 | 46 |
| 47 | 42 | 43 | 44 | 45 | 45 | 46 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 52 | 53 | 54 | 55 | 47 |
| 48 | 43 | 44 | 45 | 46 | 46 | 47 | 48 | 49 | 50 | 50 | 51 | 52 | 53 | 54 | 54 | 55 | 56 | 48 |
| 49 | 44 | 45 | 46 | 47 | 47 | 48 | 49 | 50 | 51 | 51 | 52 | 53 | 54 | 55 | 56 | 56 | 57 | 49 |
| 50 | 45 | 46 | 47 | 48 | 48 | 49 | 50 | 51 | 52 | 53 | 53 | 54 | 55 | 56 | 57 | 58 | 58 | 50 |
| 51 | 46 | 47 | 48 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 51 |
| 52 | 47 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 52 |
| 53 | 48 | 49 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 57 | 58 | 59 | 60 | 61 | 62 | 53 |
| 54 | 49 | 50 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 59 | 60 | 61 | 62 | 63 | 54 |
| 55 | 50 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 61 | 62 | 63 | 64 | 55 |
| 56 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 63 | 64 | 65 | 56 |
| 57 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 57 |
| 58 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 58 |
| 59 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 59 |
| 60 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 60 |

## TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | 71″ | 72″ | 73″ | 74″ | 75″ | 76″ | 77″ | 78″ | 79″ | 80″ | 81″ | 82″ | 83″ | 84″ | 85″ | 86″ | 87″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 |
| 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 4 |
| 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 5 |
| 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 6 |
| 7 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 7 |
| 8 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 8 |
| 9 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 9 |
| 10 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 10 |
| 11 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 11 |
| 12 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 12 |
| 13 | 15 | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 13 |
| 14 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 20 | 20 | 20 | 20 | 14 |
| 15 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 22 | 22 | 15 |
| 16 | 19 | 19 | 19 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 16 |
| 17 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 25 | 17 |
| 18 | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 26 | 18 |
| 19 | 22 | 23 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 27 | 28 | 19 |
| 20 | 24 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 20 |
| 21 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | 30 | 21 |
| 22 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | 30 | 31 | 31 | 32 | 32 | 22 |
| 23 | 27 | 28 | 28 | 28 | 29 | 29 | 30 | 30 | 30 | 31 | 31 | 31 | 32 | 32 | 33 | 33 | 33 | 23 |
| 24 | 28 | 29 | 29 | 30 | 30 | 30 | 31 | 31 | 32 | 32 | 32 | 33 | 33 | 34 | 34 | 34 | 35 | 24 |
| 25 | 30 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | 35 | 35 | 35 | 36 | 36 | 25 |
| 26 | 31 | 31 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 36 | 37 | 37 | 38 | 26 |
| 27 | 32 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 36 | 37 | 37 | 38 | 38 | 39 | 39 | 27 |
| 28 | 33 | 34 | 34 | 35 | 35 | 35 | 36 | 36 | 37 | 37 | 38 | 38 | 39 | 39 | 40 | 40 | 41 | 28 |
| 29 | 34 | 35 | 35 | 36 | 36 | 37 | 37 | 38 | 38 | 39 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 29 |
| 30 | 36 | 36 | 37 | 37 | 38 | 38 | 39 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 43 | 43 | 44 | 30 |
| 31 | 37 | 37 | 38 | 38 | 39 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 43 | 43 | 44 | 44 | 45 | 31 |
| 32 | 38 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 42 | 43 | 43 | 44 | 44 | 45 | 45 | 46 | 46 | 32 |
| 33 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 43 | 43 | 44 | 45 | 45 | 46 | 46 | 47 | 47 | 48 | 33 |
| 34 | 40 | 41 | 41 | 42 | 43 | 43 | 44 | 44 | 45 | 45 | 46 | 46 | 47 | 48 | 48 | 49 | 49 | 34 |
| 35 | 41 | 42 | 43 | 43 | 44 | 44 | 45 | 46 | 46 | 47 | 47 | 48 | 48 | 49 | 50 | 50 | 51 | 35 |
| 36 | 43 | 43 | 44 | 44 | 45 | 46 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 50 | 51 | 52 | 52 | 36 |
| 37 | 44 | 44 | 45 | 46 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 51 | 52 | 52 | 53 | 54 | 37 |
| 38 | 45 | 46 | 46 | 47 | 48 | 48 | 49 | 50 | 50 | 51 | 51 | 52 | 53 | 53 | 54 | 54 | 55 | 38 |
| 39 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 51 | 52 | 53 | 53 | 54 | 55 | 55 | 56 | 57 | 39 |
| 40 | 47 | 48 | 49 | 49 | 50 | 51 | 51 | 52 | 53 | 53 | 54 | 55 | 55 | 56 | 57 | 57 | 58 | 40 |
| 41 | 49 | 49 | 50 | 51 | 51 | 52 | 53 | 53 | 54 | 55 | 55 | 56 | 57 | 57 | 58 | 59 | 59 | 41 |
| 42 | 50 | 50 | 51 | 52 | 53 | 53 | 54 | 55 | 55 | 56 | 57 | 57 | 58 | 59 | 60 | 60 | 61 | 42 |
| 43 | 51 | 52 | 52 | 53 | 54 | 54 | 55 | 56 | 57 | 57 | 58 | 59 | 59 | 60 | 61 | 62 | 62 | 43 |
| 44 | 52 | 53 | 54 | 54 | 55 | 56 | 56 | 57 | 58 | 59 | 59 | 60 | 61 | 62 | 62 | 63 | 64 | 44 |
| 45 | 53 | 54 | 55 | 56 | 56 | 57 | 58 | 59 | 59 | 60 | 61 | 62 | 62 | 63 | 64 | 65 | 65 | 45 |
| 46 | 54 | 55 | 56 | 57 | 58 | 58 | 59 | 60 | 61 | 61 | 62 | 63 | 64 | 64 | 65 | 66 | 67 | 46 |
| 47 | 56 | 56 | 57 | 58 | 59 | 60 | 60 | 61 | 62 | 63 | 63 | 64 | 65 | 66 | 67 | 67 | 68 | 47 |
| 48 | 57 | 58 | 58 | 59 | 60 | 61 | 62 | 62 | 63 | 64 | 65 | 66 | 66 | 67 | 68 | 69 | 70 | 48 |
| 49 | 58 | 59 | 60 | 60 | 61 | 62 | 63 | 64 | 65 | 65 | 66 | 67 | 68 | 69 | 69 | 70 | 71 | 49 |
| 50 | 59 | 60 | 61 | 62 | 63 | 63 | 64 | 65 | 66 | 67 | 68 | 68 | 69 | 70 | 71 | 72 | 73 | 50 |
| 51 | 60 | 61 | 62 | 63 | 64 | 65 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 71 | 72 | 73 | 74 | 51 |
| 52 | 62 | 62 | 64 | 64 | 65 | 66 | 67 | 68 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 75 | 52 |
| 53 | 63 | 64 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 72 | 73 | 74 | 75 | 76 | 77 | 53 |
| 54 | 64 | 65 | 66 | 67 | 68 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 77 | 78 | 54 |
| 55 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 55 |
| 56 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 77 | 78 | 79 | 80 | 81 | 56 |
| 57 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 57 |
| 58 | 69 | 70 | 71 | 72 | 73 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 58 |
| 59 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 59 |
| 60 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 60 |

TABLE 12.                    [Page 515

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension, in seconds of time, the motion in one minute being given at the top and the numbers in the side column being taken for seconds.

| M. | 88″ | 89″ | 90″ | 91″ | 92″ | 93″ | 94″ | 95″ | 96″ | 97″ | 98″ | 99″ | 100″ | 101″ | 102″ | 103″ | 104″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2. | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| 3 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 3 |
| 4 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 4 |
| 5 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 5 |
| 6 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 6 |
| 7 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 7 |
| 8 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 8 |
| 9 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 9 |
| 10 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 10 |
| 11 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 11 |
| 12 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 19 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 12 |
| 13 | 19 | 19 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 23 | 13 |
| 14 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 14 |
| 15 | 22 | 22 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 15 |
| 16 | 23 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | 27 | 27 | 27 | 27 | 28 | 16 |
| 17 | 25 | 25 | 26 | 26 | 26 | 26 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | 17 |
| 18 | 26 | 27 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | 30 | 30 | 30 | 31 | 31 | 31 | 18 |
| 19 | 28 | 28 | 29 | 29 | 29 | 29 | 30 | 30 | 30 | 31 | 31 | 31 | 32 | 32 | 32 | 33 | 33 | 19 |
| 20 | 29 | 30 | 30 | 30 | 31 | 31 | 31 | 32 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | 34 | 35 | 20 |
| 21 | 31 | 31 | 32 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | 34 | 35 | 35 | 35 | 36 | 36 | 36 | 21 |
| 22 | 32 | 33 | 33 | 33 | 34 | 34 | 34 | 35 | 35 | 36 | 36 | 36 | 37 | 37 | 37 | 38 | 38 | 22 |
| 23 | 34 | 34 | 35 | 35 | 36 | 36 | 36 | 36 | 37 | 37 | 38 | 38 | 38 | 39 | 39 | 39 | 40 | 23 |
| 24 | 35 | 36 | 36 | 36 | 37 | 37 | 38 | 38 | 38 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | 42 | 24 |
| 25 | 37 | 37 | 38 | 38 | 38 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | 42 | 42 | 43 | 43 | 43 | 25 |
| 26 | 38 | 39 | 39 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 42 | 43 | 43 | 44 | 44 | 45 | 45 | 26 |
| 27 | 40 | 40 | 41 | 41 | 41 | 42 | 42 | 43 | 43 | 44 | 44 | 45 | 45 | 45 | 46 | 46 | 47 | 27 |
| 28 | 41 | 42 | 42 | 42 | 43 | 43 | 44 | 44 | 45 | 45 | 46 | 46 | 47 | 47 | 48 | 48 | 49 | 28 |
| 29 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 46 | 46 | 47 | 47 | 48 | 48 | 49 | 49 | 50 | 50 | 29 |
| 30 | 44 | 45 | 45 | 46 | 46 | 47 | 47 | 48 | 48 | 49 | 49 | 50 | 50 | 51 | 51 | 52 | 52 | 30 |
| 31 | 45 | 46 | 47 | 47 | 48 | 48 | 49 | 49 | 50 | 50 | 51 | 51 | 52 | 52 | 53 | 53 | 54 | 31 |
| 32 | 47 | 47 | 48 | 49 | 49 | 50 | 50 | 51 | 51 | 52 | 52 | 53 | 53 | 54 | 54 | 55 | 55 | 32 |
| 33 | 48 | 49 | 50 | 50 | 51 | 51 | 52 | 52 | 53 | 53 | 54 | 54 | 55 | 56 | 56 | 57 | 57 | 33 |
| 34 | 50 | 50 | 51 | 52 | 52 | 53 | 53 | 54 | 54 | 55 | 56 | 56 | 57 | 57 | 58 | 58 | 59 | 34 |
| 35 | 51 | 52 | 53 | 53 | 54 | 54 | 55 | 55 | 56 | 57 | 57 | 58 | 58 | 59 | 60 | 60 | 61 | 35 |
| 36 | 53 | 53 | 54 | 55 | 55 | 56 | 56 | 57 | 58 | 58 | 59 | 59 | 60 | 61 | 61 | 62 | 62 | 36 |
| 37 | 54 | 55 | 56 | 56 | 57 | 57 | 58 | 59 | 59 | 60 | 60 | 61 | 62 | 62 | 63 | 64 | 64 | 37 |
| 38 | 56 | 56 | 57 | 58 | 58 | 59 | 60 | 60 | 61 | 61 | 62 | 63 | 63 | 64 | 65 | 65 | 66 | 38 |
| 39 | 57 | 58 | 59 | 59 | 60 | 60 | 61 | 62 | 62 | 63 | 64 | 64 | 65 | 66 | 66 | 67 | 68 | 39 |
| 40 | 59 | 59 | 60 | 61 | 61 | 62 | 63 | 63 | 64 | 65 | 65 | 66 | 67 | 67 | 68 | 69 | 69 | 40 |
| 41 | 60 | 61 | 62 | 62 | 63 | 64 | 64 | 65 | 66 | 66 | 67 | 68 | 68 | 69 | 70 | 70 | 71 | 41 |
| 42 | 62 | 62 | 63 | 64 | 64 | 65 | 66 | 67 | 67 | 68 | 69 | 69 | 70 | 71 | 71 | 72 | 73 | 42 |
| 43 | 63 | 64 | 65 | 65 | 66 | 67 | 67 | 68 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 74 | 75 | 43 |
| 44 | 65 | 65 | 66 | 67 | 67 | 68 | 69 | 70 | 70 | 71 | 72 | 73 | 73 | 74 | 75 | 76 | 76 | 44 |
| 45 | 66 | 67 | 68 | 68 | 69 | 70 | 71 | 71 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 77 | 78 | 45 |
| 46 | 67 | 68 | 69 | 70 | 71 | 71 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 77 | 78 | 79 | 80 | 46 |
| 47 | 69 | 70 | 71 | 71 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 47 |
| 48 | 70 | 71 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 82 | 82 | 83 | 48 |
| 49 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 82 | 82 | 83 | 84 | 85 | 49 |
| 50 | 73 | 74 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 82 | 83 | 83 | 84 | 85 | 86 | 87 | 50 |
| 51 | 75 | 76 | 77 | 77 | 78 | 79 | 80 | 81 | 82 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 88 | 51 |
| 52 | 76 | 77 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 88 | 89 | 90 | 52 |
| 53 | 78 | 79 | 80 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 87 | 88 | 89 | 90 | 91 | 92 | 53 |
| 54 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 54 |
| 55 | 81 | 82 | 83 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 94 | 95 | 55 |
| 56 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 56 |
| 57 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 96 | 97 | 98 | 99 | 57 |
| 58 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 58 |
| 59 | 87 | 88 | 89 | 90 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 59 |
| 60 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 60 |

# TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variatior of the Moon's Declination or Right Ascension, in seconds of time, the motion in one minute being given at the top and the numbers in the side column being taken for seconds.

| M. | Horary motion. | | | | | | | | | | | | | | M. |
| | 105″ | 106″ | 107″ | 108″ | 109″ | 110″ | 111″ | 112″ | 113″ | 114″ | 115″ | 116″ | 117″ | 118″ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 |
| 3 | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 3 |
| 4 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | ·8 | 8 | 4 |
| 5 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 5 |
| 6 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 6 |
| 7 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 7 |
| 8 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 8 |
| 9 | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 | 9 |
| 10 | 18 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 20 | 20 | 10 |
| 11 | 19 | 19 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 22 | 11 |
| 12 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 24 | 12 |
| 13 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 26 | 13 |
| 14 | 25 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | 27 | 27 | 27 | 27 | 28 | 14 |
| 15 | 26 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | 30 | 15 |
| 16 | 28 | 28 | 29 | 29 | 29 | 29 | 30 | 30 | 30 | 30 | 31 | 31 | 31 | 31 | 16 |
| 17 | 30 | 30 | 30 | 31 | 31 | 31 | 31 | 32 | 32 | 32 | 33 | 33 | 33 | 33 | 17 |
| 18 | 32 | 32 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | 34 | 35 | 35 | 35 | 35 | 18 |
| 19 | 33 | 34 | 34 | 34 | 35 | 35 | 35 | 35 | 36 | 36 | 36 | 37 | 37 | 37 | 19 |
| 20 | 35 | 35 | 36 | 36 | 36 | 37 | 37 | 37 | 38 | 38 | 38 | 39 | 39 | 39 | 20 |
| 21 | 37 | 37 | 37 | 38 | 38 | 39 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | 41 | 21 |
| 22 | 39 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | 41 | 42 | 42 | 43 | 43 | 43 | 22 |
| 23 | 40 | 41 | 41 | 41 | 42 | 42 | 43 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 23 |
| 24 | 42 | 42 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 46 | 46 | 46 | 47 | 47 | 24 |
| 25 | 44 | 44 | 45 | 45 | 45 | 46 | 46 | 47 | 47 | 48 | 48 | 48 | 49 | 49 | 25 |
| 26 | 46 | 46 | 46 | 47 | 47 | 48 | 48 | 49 | 49 | 49 | 50 | 50 | 51 | 51 | 26 |
| 27 | 47 | 48 | 48 | 49 | 49 | 50 | 50 | 50 | 51 | 51 | 52 | 52 | 53 | 53 | 27 |
| 28 | 49 | 49 | 50 | 50 | 51 | 51 | 52 | 52 | 53 | 53 | 54 | 54 | 55 | 55 | 28 |
| 29 | 51 | 51 | 52 | 52 | 53 | 53 | 54 | 54 | 55 | 55 | 56 | 56 | 57 | 57 | 29 |
| 30 | 53 | 53 | 54 | 54 | 55 | 55 | 56 | 56 | 57 | 57 | 58 | 58 | 59 | 59 | 30 |
| 31 | 54 | 55 | 55 | 56 | 56 | 57 | 57 | 58 | 58 | 59 | 59 | 60 | 60 | 61 | 31 |
| 32 | 56 | 57 | 57 | 58 | 58 | 59 | 59 | 60 | 60 | 61 | 61 | 62 | 62 | 63 | 32 |
| 33 | 58 | 58 | 59 | 59 | 60 | 61 | 61 | 62 | 62 | 63 | 63 | 64 | 64 | 65 | 33 |
| 34 | 60 | 60 | 61 | 61 | 62 | 62 | 63 | 63 | 64 | 65 | 65 | 66 | 66 | 67 | 34 |
| 35 | 61 | 62 | 62 | 63 | 64· | 64 | 65 | 65 | 66 | 67 | 67 | 68 | 68 | 69 | 35 |
| 36 | 63 | 64 | 64 | 65 | 65 | 66 | 67 | 67 | 68 | 68 | 69 | 70 | 70 | 71 | 36 |
| 37 | 65 | 65 | 66 | 67 | 67 | 68 | 68 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 37 |
| 38 | 67 | 67 | 68 | 68 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 73 | 74 | 75 | 38 |
| 39 | 68 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 39 |
| 40 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 77 | 78 | 79 | 40 |
| 41 | 72 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 77 | 78 | 79 | 79 | 80 | 81 | 41 |
| 42 | 74 | 74 | 75 | 76 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 42 |
| 43 | 75 | 76 | 77 | 77 | 78 | 79 | 80 | 80 | 81 | 82 | 82 | 83 | 84 | 85 | 43 |
| 44 | 77· | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 84 | 85 | 86 | 87 | 44 |
| 45 | 79 | 80 | 80 | 81 | 82 | 83 | 83 | 84 | 85 | 86 | 86 | 87 | 88 | 89 | 45 |
| 46 | 81 | 81 | 82 | 83 | 84 | 84 | 85 | 86 | 87 | 87 | 88 | 89 | 90 | 90 | 46 |
| 47 | 82 | 83 | 84 | 85 | 85 | 86 | 87 | 88 | 89 | 89 | 90 | 91 | 92 | 92 | 47 |
| 48 | 84 | 85 | 86 | 86 | 87 | 88 | 89 | 90 | 90 | 91 | 92 | 93 | 94 | 94 | 48 |
| 49 | 86 | 87 | 87 | 88 | 89 | 90 | 91 | 91 | 92 | 93 | 94 | 95 | 96 | 96 | 49 |
| 50 | 88 | 88 | 89 | 90 | 91 | 92 | 93 | 93 | 94 | 95 | 96 | 97 | 98 | 98 | 50 |
| 51 | 89 | 90 | 91 | 92 | 93 | 94 | 94 | 95 | 96 | 97 | 98 | 99 | 99 | 100 | 51 |
| 52 | 91 | 92 | 93 | 94 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 101 | 102 | 52 |
| 53 | 93 | 94 | 95 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 102 | 103 | 104 | 53 |
| 54 | 95 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 104 | 105 | 106 | 54 |
| 55 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 105 | 106 | 107 | 108 | 55 |
| 56 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 105 | 106 | 107 | 108 | 109 | 110 | 56 |
| 57 | 100 | 101 | 102 | 103 | 104 | 105 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 57 |
| 58 | 102 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 58 |
| 59 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 59 |
| 60 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 60 |

TABLE 12. [Page 517

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column. Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | Horary motion. | | | | | | | | | | | | | | M. |
|----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----|
|    | 119″ | 120″ | 121″ | 122″ | 123″ | 124″ | 125″ | 126″ | 127″ | 128″ | 129″ | 130″ | 131″ | 132″ |    |
| 1  | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 2  | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 |
| 3  | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 3 |
| 4  | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 4 |
| 5  | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 5 |
| 6  | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 6 |
| 7  | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 7 |
| 8  | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 | 8 |
| 9  | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 20 | 20 | 20 | 9 |
| 10 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 22 | 10 |
| 11 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 11 |
| 12 | 24 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | 26 | 12 |
| 13 | 26 | 26 | 26 | 26 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 29 | 13 |
| 14 | 28 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | 30 | 30 | 30 | 30 | 31 | 31 | 14 |
| 15 | 30 | 30 | 30 | 31 | 31 | 31 | 31 | 32 | 32 | 32 | 32 | 33 | 33 | 33 | 15 |
| 16 | 32 | 32 | 32 | 33 | 33 | 33 | 33 | 34 | 34 | 34 | 34 | 35 | 35 | 35 | 16 |
| 17 | 34 | 34 | 34 | 35 | 35 | 35 | 35 | 36 | 36 | 36 | 36 | 37 | 37 | 37 | 17 |
| 18 | 36 | 36 | 36 | 37 | 37 | 37 | 38 | 38 | 38 | 38 | 39 | 39 | 39 | 40 | 18 |
| 19 | 38 | 38 | 38 | 39 | 39 | 39 | 40 | 40 | 40 | 40 | 41 | 41 | 41 | 42 | 19 |
| 20 | 40 | 40 | 40 | 41 | 41 | 41 | 42 | 42 | 42 | 42 | 43 | 43 | 43 | 44 | 20 |
| 21 | 42 | 42 | 42 | 43 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 46 | 46 | 46 | 21 |
| 22 | 44 | 44 | 44 | 45 | 45 | 45 | 46 | 46 | 47 | 47 | 47 | 48 | 48 | 48 | 22 |
| 23 | 46 | 46 | 46 | 47 | 47 | 48 | 48 | 48 | 49 | 49 | 49 | 50 | 50 | 51 | 23 |
| 24 | 48 | 48 | 48 | 49 | 49 | 50 | 50 | 50 | 51 | 51 | 52 | 52 | 52 | 53 | 24 |
| 25 | 50 | 50 | 50 | 51 | 51 | 52 | 52 | 53 | 53 | 53 | 54 | 54 | 55 | 55 | 25 |
| 26 | 52 | 52 | 52 | 53 | 53 | 54 | 54 | 55 | 55 | 55 | 56 | 56 | 57 | 57 | 26 |
| 27 | 54 | 54 | 54 | 55 | 55 | 56 | 56 | 57 | 57 | 58 | 58 | 59 | 59 | 59 | 27 |
| 28 | 56 | 56 | 56 | 57 | 57 | 58 | 58 | 59 | 59 | 60 | 60 | 61 | 61 | 62 | 28 |
| 29 | 58 | 58 | 58 | 59 | 59 | 60 | 60 | 61 | 61 | 62 | 62 | 63 | 63 | 64 | 29 |
| 30 | 60 | 60 | 61 | 61 | 62 | 62 | 63 | 63 | 64 | 64 | 65 | 65 | 66 | 66 | 30 |
| 31 | 61 | 62 | 63 | 63 | 64 | 64 | 65 | 65 | 66 | 66 | 67 | 67 | 68 | 68 | 31 |
| 32 | 63 | 64 | 65 | 65 | 66 | 66 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 32 |
| 33 | 65 | 66 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 33 |
| 34 | 67 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 74 | 75 | 34 |
| 35 | 69 | 70 | 71 | 71 | 72 | 72 | 73 | 74 | 74 | 75 | 75 | 76 | 76 | 77 | 35 |
| 36 | 71 | 72 | 73 | 73 | 74 | 74 | 75 | 76 | 76 | 77 | 77 | 78 | 79 | 79 | 36 |
| 37 | 73 | 74 | 75 | 75 | 76 | 76 | 77 | 78 | 78 | 79 | 80 | 80 | 81 | 81 | 37 |
| 38 | 75 | 76 | 77 | 77 | 78 | 79 | 79 | 80 | 80 | 81 | 82 | 82 | 83 | 84 | 38 |
| 39 | 77 | 78 | 79 | 79 | 80 | 81 | 81 | 82 | 83 | 83 | 84 | 85 | 85 | 86 | 39 |
| 40 | 79 | 80 | 81 | 81 | 82 | 83 | 83 | 84 | 85 | 85 | 86 | 87 | 87 | 88 | 40 |
| 41 | 81 | 82 | 83 | 83 | 84 | 85 | 85 | 86 | 87 | 87 | 88 | 89 | 90 | 90 | 41 |
| 42 | 83 | 84 | 85 | 85 | 86 | 87 | 88 | 88 | 89 | 90 | 90 | 91 | 92 | 92 | 42 |
| 43 | 85 | 86 | 87 | 87 | 88 | 89 | 90 | 90 | 91 | 92 | 92 | 93 | 94 | 95 | 43 |
| 44 | 87 | 88 | 89 | 89 | 90 | 91 | 92 | 92 | 93 | 94 | 95 | 95 | 96 | 97 | 44 |
| 45 | 89 | 90 | 91 | 92 | 92 | 93 | 94 | 95 | 95 | 96 | 97 | 98 | 98 | 99 | 45 |
| 46 | 91 | 92 | 93 | 94 | 94 | 95 | 96 | 97 | 97 | 98 | 99 | 100 | 100 | 101 | 46 |
| 47 | 93 | 94 | 95 | 96 | 96 | 97 | 98 | 99 | 99 | 100 | 101 | 102 | 103 | 103 | 47 |
| 48 | 95 | 96 | 97 | 98 | 98 | 99 | 100 | 101 | 102 | 102 | 103 | 104 | 105 | 106 | 48 |
| 49 | 97 | 98 | 99 | 100 | 100 | 101 | 102 | 103 | 104 | 105 | 105 | 106 | 107 | 108 | 49 |
| 50 | 99 | 100 | 101 | 102 | 103 | 103 | 104 | 105 | 106 | 107 | 108 | 108 | 109 | 110 | 50 |
| 51 | 101 | 102 | 103 | 104 | 105 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 111 | 112 | 51 |
| 52 | 103 | 104 | 105 | 106 | 107 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 114 | 52 |
| 53 | 105 | 106 | 107 | 108 | 109 | 110 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 53 |
| 54 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 54 |
| 55 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 116 | 117 | 118 | 119 | 120 | 121 | 55 |
| 56 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 119 | 120 | 121 | 122 | 123 | 56 |
| 57 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 124 | 125 | 57 |
| 58 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 58 |
| 59 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 59 |
| 60 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 60 |

# TABLE 12.

For finding the Variation of the Sun's Right Ascension or Declination, or of the Equation of Time, in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column.  Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | 133″ | 134″ | 135″ | 136″ | 137″ | 138″ | 139″ | 140″ | 141″ | 142″ | 143″ | 144″ | 145″ | 146″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Horary motion. | | | | | | | | | |
| 1 | 2 | 2 | 2 | 2 | 2 | 2 | ·2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 2 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| 3 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 3 |
| 4 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 4 |
| 5 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 5 |
| 6 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 6 |
| 7 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 7 |
| 8 | 18 | 18 | 1ᚷ | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 8 |
| 9 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 22 | 22 | 22 | 9 |
| 10 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 | 24 | 10 |
| 11 | 24 | 25 | 25 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | 26 | 27 | 27 | 11 |
| 12 | 27 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | 12 |
| 13 | 29 | 29 | 29 | 29 | 30 | 30 | 30 | 30 | 31 | 31 | 31 | 31 | 31 | 32 | 13 |
| 14 | 31 | 31 | 32 | 32 | 32 | 32 | 32 | 33 | 33 | 33 | 33 | 34 | 34 | 34 | 14 |
| 15 | 33 | 34 | 34 | 34 | 34 | 35 | 35 | 35 | 35 | 36 | 36 | 36 | 36 | 37 | 15 |
| 16 | 35 | 36 | 36 | 36 | 37 | 37 | 37 | 37 | 38 | 38 | 38 | 38 | 39 | 39 | 16 |
| 17 | 38 | 38 | 38 | 39 | 39 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | 41 | 41 | 17 |
| 18 | 40 | 40 | 41 | 41 | 41 | 41 | 42 | 42 | 42 | 43 | 43 | 43 | 44 | 44 | 18 |
| 19 | 42 | 42 | 43 | 43 | 43 | 44 | 44 | 44 | 45 | 45 | 45 | 46 | 46 | 46 | 19 |
| 20 | 44 | 45 | 45 | 45 | 46 | 46 | 46 | 47 | 47 | 47 | 48 | 48 | 48 | 49 | 20 |
| 21 | 47 | 47 | 47 | 48 | 48 | 48 | 49 | 49 | 49 | 50 | 50 | 50 | 51 | 51 | 21 |
| 22 | 49 | 49 | 50 | 50 | 50 | 51 | 51 | 51 | 52 | 52 | 52 | 53 | 53 | 54 | 22 |
| 23 | 51 | 51 | 52 | 52 | 53 | 53 | 53 | 54 | 54 | 54 | 55 | 55 | 56 | 56 | 23 |
| 24 | 53 | 54 | 54 | 54 | 55 | 55 | 56 | 56 | 56 | 57 | 57 | 58 | 58 | 58 | 24 |
| 25 | 55 | 56 | 56 | 57 | 57 | 58 | 58 | 58 | 59 | 59 | 60 | 60 | 60 | 61 | 25 |
| 26 | 58 | 58 | 59 | 59 | 59 | 60 | 60 | 61 | 61 | 62 | 62 | 62 | 63 | 63 | 26 |
| 27 | 60 | 60 | 61 | 61 | 62 | 62 | 63 | 63 | 63 | 64 | 64 | 65 | 65 | 66 | 27 |
| 28 | 62 | 63 | 63 | 63 | 64 | 64 | 65 | 65 | 66 | 66 | 67 | 67 | 68 | 68 | 28 |
| 29 | 64 | 65 | 65 | 66 | 66 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 29 |
| 30 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 30 |
| 31 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 31 |
| 32 | 71 | 71 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 | 76 | 77 | 77 | 78 | 32 |
| 33 | 73 | 74 | 74 | 75 | 75 | 76 | 76 | 77 | 78 | 78 | 79 | 79 | 80 | 80 | 33 |
| 34 | 75 | 76 | 77 | 77 | 78 | 78 | 79 | 79 | 80 | 80 | 81 | 82 | 82 | 83 | 34 |
| 35 | 78 | 78 | 79 | 79 | 80 | 81 | 81 | 82 | 82 | 83 | 83 | 84 | 85 | 85 | 35 |
| 36 | 80 | 80 | 81 | 82 | 82 | 83 | 83 | 84 | 85 | 85 | 86 | 86 | 87 | 88 | 36 |
| 37 | 82 | 83 | 83 | 84 | 84 | 85 | 86 | 86 | 87 | 88 | 88 | 89 | 89 | 90 | 37 |
| 38 | 84 | 85 | 85 | 86 | 87 | 87 | 88 | 89 | 89 | 90 | 91 | 91 | 92 | 92 | 38 |
| 39 | 86 | 87 | 88 | 88 | 89 | 90 | 90 | 91 | 92 | 92 | 93 | 94 | 94 | 95 | 39 |
| 40 | 89 | 89 | 90 | 91 | 91 | 92 | 93 | 93 | 94 | 95 | 95 | 96 | 97 | 97 | 40 |
| 41 | 91 | 92 | 92 | 93 | 94 | 94 | 95 | 96 | 96 | 97 | 98 | 98 | 99 | 100 | 41 |
| 42 | 93 | 94 | 95 | 95 | 96 | 97 | 97 | 98 | 99 | 99 | 100 | 101 | 102 | 102 | 42 |
| 43 | 95 | 96 | 97 | 97 | 98 | 99 | 100 | 100 | 101 | 102 | 102 | 103 | 104 | 105 | 43 |
| 44 | 98 | 98 | 99 | 100 | 100 | 101 | 102 | 103 | 103 | 104 | 105 | 106 | 106 | 107 | 44 |
| 45 | 100 | 101 | 101 | 102 | 103 | 104 | 104 | 105 | 106 | 107 | 107 | 108 | 109 | 110 | 45 |
| 46 | 102 | 103 | 104 | 104 | 105 | 106 | 107 | 107 | 108 | 109 | 110 | 110 | 111 | 112 | 46 |
| 47 | 104 | 105 | 106 | 107 | 107 | 108 | 109 | 110 | 110 | 111 | 112 | 113 | 114 | 114 | 47 |
| 48 | 106 | 107 | 108 | 109 | 110 | 110 | 111 | 112 | 113 | 114 | 114 | 115 | 116 | 117 | 48 |
| 49 | 109 | 109 | 110 | 111 | 112 | 113 | 114 | 114 | 115 | 116 | 117 | 118 | 118 | 119 | 49 |
| 50 | 111 | 112 | 113 | 113 | 114 | 115 | 116 | 117 | 118 | 118 | 119 | 120 | 121 | 122 | 50 |
| 51 | 113 | 114 | 115 | 116 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 122 | 123 | 124 | 51 |
| 52 | 115 | 116 | 117 | 118 | 119 | 120 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 52 |
| 53 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 125 | 126 | 127 | 128 | 129 | 53 |
| 54 | 120 | 121 | 122 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 131 | 54 |
| 55 | 122 | 123 | 124 | 125 | 126 | 127 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 55 |
| 56 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 133 | 134 | 135 | 136 | 56 |
| 57 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 57 |
| 58 | 129 | 130 | 131 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 58 |
| 59 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 59 |
| 60 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 60 |

TABLE 12.                              [Page 519

For finding the Variation of the Sun's Right Ascension, or Declination, or of the Equation of Time in any number of minutes of time, the Horary Motion being given at the top of the page in seconds, and the number of minutes of time in the side column.  Also for finding the Variation of the Moon's Declination or Right Ascension in seconds of time, the motion in one minute being given at the top, and the numbers in the side column being taken for seconds.

| M. | 147″ | 148″ | 149″ | 150″ | 151″ | 152″ | 153″ | 154″ | 155″ | 156″ | 157″ | 158″ | 159″ | 160″ | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 |
| 3 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 3 |
| 4 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 4 |
| 5 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 5 |
| 6 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 16 | 6 |
| 7 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 7 |
| 8 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 8 |
| 9 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 9 |
| 10 | 25 | 25 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | 26 | 26 | 27 | 27 | 10 |
| 11 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | 29 | 11 |
| 12 | 29 | 30 | 30 | 30 | 30 | 30 | 31 | 31 | 31 | 31 | 31 | 32 | 32 | 32 | 12 |
| 13 | 32 | 32 | 32 | 33 | 33 | 33 | 33 | 33 | 34 | 34 | 34 | 34 | 34 | 35 | 13 |
| 14 | 34 | 35 | 35 | 35 | 35 | 35 | 36 | 36 | 36 | 36 | 36 | 37 | 37 | 37 | 14 |
| 15 | 37 | 37 | 37 | 38 | 38 | 38 | 38 | 39 | 39 | 39 | 39 | 40 | 40 | 40 | 15 |
| 16 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | 41 | 41 | 42 | 42 | 42 | 42 | 43 | 16 |
| 17 | 42 | 42 | 42 | 43 | 43 | 43 | 43 | 44 | 44 | 44 | 44 | 45 | 45 | 45 | 17 |
| 18 | 44 | 44 | 45 | 45 | 45 | 46 | 46 | 46 | 47 | 47 | 47 | 47 | 48 | 48 | 18 |
| 19 | 47 | 47 | 47 | 48 | 48 | 48 | 49 | 49 | 49 | 50 | 50 | 50 | 51 | 51 | 19 |
| 20 | 49 | 49 | 50 | 50 | 50 | 51 | 51 | 51 | 52 | 52 | 52 | 53 | 53 | 53 | 20 |
| 21 | 51 | 52 | 52 | 53 | 53 | 53 | 54 | 54 | 54 | 55 | 55 | 55 | 56 | 56 | 21 |
| 22 | 54 | 54 | 55 | 55 | 55 | 56 | 56 | 57 | 57 | 57 | 58 | 58 | 58 | 59 | 22 |
| 23 | 56 | 57 | 57 | 58 | 58 | 58 | 59 | 59 | 59 | 60 | 60 | 61 | 61 | 61 | 23 |
| 24 | 59 | 59 | 60 | 60 | 60 | 61 | 61 | 62 | 62 | 62 | 63 | 63 | 64 | 64 | 24 |
| 25 | 61 | 62 | 62 | 63 | 63 | 63 | 64 | 64 | 65 | 65 | 65 | 66 | 66 | 67 | 25 |
| 26 | 64 | 64 | 65 | 65 | 65 | 66 | 66 | 67 | 67 | 68 | 68 | 68 | 69 | 69 | 26 |
| 27 | 66 | 67 | 67 | 68 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 27 |
| 28 | 69 | 69 | 70 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 28 |
| 29 | 71 | 72 | 72 | 73 | 73 | 73 | 74 | 74 | 75 | 75 | 76 | 76 | 77 | 77 | 29 |
| 30 | 74 | 74 | 75 | 75 | 76 | 76 | 77 | 77 | 78 | 78 | 79 | 79 | 80 | 80 | 30 |
| 31 | 76 | 76 | 77 | 78 | 78 | 79 | 79 | 80 | 80 | 81 | 81 | 82 | 82 | 83 | 31 |
| 32 | 78 | 79 | 79 | 80 | 81 | 81 | 82 | 82 | 83 | 83 | 84 | 84 | 85 | 85 | 32 |
| 33 | 81 | 81 | 82 | 83 | 83 | 84 | 84 | 85 | 85 | 86 | 86 | 87 | 87 | 88 | 33 |
| 34 | 83 | 84 | 84 | 85 | 86 | 86 | 87 | 87 | 88 | 88 | 89 | 90 | 90 | 91 | 34 |
| 35 | 86 | 86 | 87 | 88 | 88 | 89 | 89 | 90 | 90 | 91 | 92 | 92 | 93 | 93 | 35 |
| 36 | 88 | 89 | 89 | 90 | 91 | 91 | 92 | 92 | 93 | 94 | 94 | 94 | 95 | 96 | 36 |
| 37 | ·91 | 91 | 92 | 93 | 93 | 94 | 94 | 95 | 96 | 96 | 97 | 97 | 98 | 99 | 37 |
| 38 | 93 | 94 | 94 | 95 | 96 | 96 | 97 | 98 | 98 | 99 | 99 | 100 | 101 | 101 | 38 |
| 39 | 96 | 96 | 97 | 98 | 98 | 99 | 99 | 100 | 101 | 101 | 102 | 103 | 103 | 104 | 39 |
| 40 | 98 | 99 | 99 | 100 | 101 | 101 | 102 | 103 | 103 | 104 | 105 | 105 | 106 | 107 | 40 |
| 41 | 100 | 101 | 102 | 103 | 103 | 104 | 105 | 105 | 106 | 107 | 107 | 108 | 109 | 109 | 41 |
| 42 | 103 | 104 | 104 | 105 | 106 | 106 | 107 | 108 | 109 | 109 | 110 | 111 | 111 | 112 | 42 |
| 43 | 105 | 106 | 107 | 108 | 108 | 109 | 110 | 110 | 111 | 112 | 113 | 113 | 114 | 115 | 43 |
| 44 | 108 | 109 | 109 | 110 | 111 | 111 | 112 | 113 | 114 | 114 | 115 | 116 | 117 | 117 | 44 |
| 45 | 110 | 111 | 112 | 113 | 113 | 114 | 115 | 116 | 116 | 117 | 118 | 119 | 119 | 120 | 45 |
| 46 | 113 | 113 | 114 | 115 | 116 | 117 | 117 | 118 | 119 | 120 | 120 | 121 | 122 | 123 | 46 |
| 47 | 115 | 116 | 117 | 118 | 118 | 119 | 120 | 121 | 121 | 122 | 123 | 124 | 125 | 125 | 47 |
| 48 | 118 | 118 | 119 | 120 | 121 | 122 | 122 | 123 | 124 | 125 | 126 | 126 | 127 | 128 | 48 |
| 49 | 120 | 121 | 122 | 123 | 123 | 124 | 125 | 126 | 127 | 127 | 128 | 129 | 130 | 131 | 49 |
| 50 | 123 | 123 | 124 | 125 | 126 | 127 | 128 | 128 | 129 | 130 | 131 | 132 | 133 | 133 | 50 |
| 51 | 125 | 126 | 127 | 128 | 128 | 129 | 130 | 131 | 132 | 133 | 133 | 134 | 135 | 136 | 51 |
| 52 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 52 |
| 53 | 130 | 131 | 132 | 133 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 140 | 141 | 53 |
| 54 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 140 | 141 | 142 | 143 | 144 | 54 |
| 55 | 135 | 136 | 137 | 138 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 55 |
| 56 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 147 | 148 | 149 | 56 |
| 57 | 140 | 141 | 142 | 143 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 57 |
| 58 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 58 |
| 59 | 145 | 146 | 147 | 148 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 59 |
| 60 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 60 |

# TABLE 13.

For finding the Sun's change of Right Ascension for any given number of hours.

| Hourly variation. | Number of hours. | | | | | | | | | | | | Hourly variation. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* | *s.* |
| 8.50 | 8.5 | 17.0 | 25.5 | 34.0 | 42.5 | 51.0 | 59.5 | 68.0 | 76.5 | 85.0 | 93.5 | 102.0 | 8.50 |
| 8.55 | 8.6 | 17.1 | 25.7 | 34.2 | 42.8 | 51.3 | 59.9 | 68.4 | 77.0 | 85.5 | 94.1 | 102.6 | 8.55 |
| 8.60 | 8.6 | 17.2 | 25.8 | 34.4 | 43.0 | 51.6 | 60.2 | 68.8 | 77.4 | 86.0 | 94.6 | 103.2 | 8.60 |
| 8.65 | 8.7 | 17.3 | 26.0 | 34.6 | 43.3 | 51.9 | 60.6 | 69.2 | 77.9 | 86.5 | 95.2 | 103.8 | 8.65 |
| 8.70 | 8.7 | 17.4 | 26.1 | 34.8 | 43.5 | 52.2 | 60.9 | 69.6 | 78.3 | 87.0 | 95.7 | 104.4 | 8.70 |
| 8.75 | 8.8 | 17.5 | 26.3 | 35.0 | 43.8 | 52.5 | 61.3 | 70.0 | 78.8 | 87.5 | 96.3 | 105.0 | 8.75 |
| 8.80 | 8.8 | 17.6 | 26.4 | 35.2 | 44.0 | 52.8 | 61.6 | 70.4 | 79.2 | 88.0 | 96.8 | 105.6 | 8.80 |
| 8.85 | 8.9 | 17.7 | 26.6 | 35.4 | 44.3 | 53.1 | 62.0 | 70.8 | 79.7 | 88.5 | 97.4 | 106.2 | 8.85 |
| 8.90 | 8.9 | 17.8 | 26.7 | 35.6 | 44.5 | 53.4 | 62.3 | 71.2 | 80.1 | 89.0 | 97.9 | 106.8 | 8.90 |
| 8.95 | 9.0 | 17.9 | 26.9 | 35.8 | 44.8 | 53.7 | 62.7 | 71.6 | 80.6 | 89.5 | 98.5 | 107.4 | 8.95 |
| 9.00 | 9.0 | 18.0 | 27.0 | 36.0 | 45.0 | 54.0 | 63.0 | 72.0 | 81.0 | 90.0 | 99.0 | 108.0 | 9.00 |
| 9.05 | 9.1 | 18.1 | 27.2 | 36.2 | 45.3 | 54.3 | 63.4 | 72.4 | 81.5 | 90.5 | 99.6 | 108.6 | 9.05 |
| 9.10 | 9.1 | 18.2 | 27.3 | 36.4 | 45.5 | 54.6 | 63.7 | 72.8 | 81.9 | 91.0 | 100.1 | 109.2 | 9.10 |
| 9.15 | 9.2 | 18.3 | 27.5 | 36.6 | 45.8 | 54.9 | 64.1 | 73.2 | 82.4 | 91.5 | 100.7 | 109.8 | 9.15 |
| 9.20 | 9.2 | 18.4 | 27.6 | 36.8 | 46.0 | 55.2 | 64.4 | 73.6 | 82.8 | 92.0 | 101.2 | 110.4 | 9.20 |
| 9.25 | 9.3 | 18.5 | 27.8 | 37.0 | 46.3 | 55.5 | 64.8 | 74.0 | 83.3 | 92.5 | 101.8 | 111.0 | 9.25 |
| 9.30 | 9.3 | 18.6 | 27.9 | 37.2 | 46.5 | 55.8 | 65.1 | 74.4 | 83.7 | 93.0 | 102.3 | 111.6 | 9.30 |
| 9.35 | 9.4 | 18.7 | 28.1 | 37.4 | 46.8 | 56.1 | 65.5 | 74.8 | 84.2 | 93.5 | 102.9 | 112.2 | 9.35 |
| 9.40 | 9.4 | 18.8 | 28.2 | 37.6 | 47.0 | 56.4 | 65.8 | 75.2 | 84.6 | 94.0 | 103.4 | 112.8 | 9.40 |
| 9.45 | 9.5 | 18.9 | 28.4 | 37.8 | 47.3 | 56.7 | 66.2 | 75.6 | 85.1 | 94.5 | 104.0 | 113.4 | 9.45 |
| 9.50 | 9.5 | 19.0 | 28.5 | 38.0 | 47.5 | 57.0 | 66.5 | 76.0 | 85.5 | 95.0 | 104.5 | 114.0 | 9.50 |
| 9.55 | 9.6 | 19.1 | 28.7 | 38.2 | 47.8 | 57.3 | 66.9 | 76.4 | 86.0 | 95.5 | 105.1 | 114.6 | 9.55 |
| 9.60 | 9.6 | 19.2 | 28.8 | 38.4 | 48.0 | 57.6 | 67.2 | 76.8 | 86.4 | 96.0 | 105.6 | 115.2 | 9.60 |
| 9.65 | 9.7 | 19.3 | 29.0 | 38.6 | 48.3 | 57.9 | 67.6 | 77.2 | 86.9 | 96.5 | 106.2 | 115.8 | 9.65 |
| 9.70 | 9.7 | 19.4 | 29.1 | 38.8 | 48.5 | 58.2 | 67.9 | 77.6 | 87.3 | 97.0 | 106.7 | 116.4 | 9.70 |
| 9.75 | 9.8 | 19.5 | 29.3 | 39.0 | 48.8 | 58.5 | 68.3 | 78.0 | 87.8 | 97.5 | 107.3 | 117.0 | 9.75 |
| 9.80 | 9.8 | 19.6 | 29.4 | 39.2 | 49.0 | 58.8 | 68.6 | 78.4 | 88.2 | 98.0 | 107.8 | 117.6 | 9.80 |
| 9.85 | 9.9 | 19.7 | 29.6 | 39.4 | 49.3 | 59.1 | 69.0 | 78.8 | 88.7 | 98.5 | 108.4 | 118.2 | 9.85 |
| 9.90 | 9.9 | 19.8 | 29.7 | 39.6 | 49.5 | 59.4 | 69.3 | 79.2 | 89.1 | 99.0 | 108.9 | 118.8 | 9.90 |
| 9.95 | 10.0 | 19.9 | 29.9 | 39.8 | 49.8 | 59.7 | 69.7 | 79.6 | 89.6 | 99.5 | 109.5 | 119.4 | 9.95 |
| 10.00 | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 60.0 | 70.0 | 80.0 | 90.0 | 100.0 | 110.0 | 120.0 | 10.00 |
| 10.05 | 10.1 | 20.1 | 30.2 | 40.2 | 50.3 | 60.3 | 70.4 | 80.4 | 90.5 | 100.5 | 110.6 | 120.6 | 10.05 |
| 10.10 | 10.1 | 20.2 | 30.3 | 40.4 | 50.5 | 60.6 | 70.7 | 80.8 | 90.9 | 101.0 | 111.1 | 121.2 | 10.10 |
| 10.15 | 10.2 | 20.3 | 30.5 | 40.6 | 50.8 | 60.9 | 71.1 | 81.2 | 91.4 | 101.5 | 111.7 | 121.8 | 10.15 |
| 10.20 | 10.2 | 20.4 | 30.6 | 40.8 | 51.0 | 61.2 | 71.4 | 81.6 | 91.8 | 102.0 | 112.2 | 122.4 | 10.20 |
| 10.25 | 10.3 | 20.5 | 30.8 | 41.0 | 51.3 | 61.5 | 71.8 | 82.0 | 92.3 | 102.5 | 112.8 | 123.0 | 10.25 |
| 10.30 | 10.3 | 20.6 | 30.9 | 41.2 | 51.5 | 61.8 | 72.1 | 82.4 | 92.7 | 103.0 | 113.3 | 123.6 | 10.30 |
| 10.35 | 10.4 | 20.7 | 31.1 | 41.4 | 51.8 | 62.1 | 72.5 | 82.8 | 93.2 | 103.5 | 113.9 | 124.2 | 10.35 |
| 10.40 | 10.4 | 20.8 | 31.2 | 41.6 | 52.0 | 62.4 | 72.8 | 83.2 | 93.6 | 104.0 | 114.4 | 124.8 | 10.40 |
| 10.45 | 10.5 | 20.9 | 31.4 | 41.8 | 52.3 | 62.7 | 73.2 | 83.6 | 94.1 | 104.5 | 115.0 | 125.4 | 10.45 |
| 10.50 | 10.5 | 21.0 | 31.5 | 42.0 | 52.5 | 63.0 | 73.5 | 84.0 | 94.5 | 105.0 | 115.5 | 126.0 | 10.50 |
| 10.55 | 10.6 | 21.1 | 31.7 | 42.2 | 52.8 | 63.3 | 73.9 | 84.4 | 95.0 | 105.5 | 116.1 | 126.6 | 10.55 |
| 10.60 | 10.6 | 21.2 | 31.8 | 42.4 | 53.0 | 63.6 | 74.2 | 84.8 | 95.4 | 106.0 | 116.6 | 127.2 | 10.60 |
| 10.65 | 10.7 | 21.3 | 32.0 | 42.6 | 53.3 | 63.9 | 74.6 | 85.2 | 95.9 | 106.5 | 117.2 | 127.8 | 10.65 |
| 10.70 | 10.7 | 21.4 | 32.1 | 42.8 | 53.5 | 64.2 | 74.9 | 85.6 | 96.3 | 107.0 | 117.7 | 128.4 | 10.70 |
| 10.75 | 10.8 | 21.5 | 32.3 | 43.0 | 53.8 | 64.5 | 75.3 | 86.0 | 96.8 | 107.5 | 118.3 | 129.0 | 10.75 |
| 10.80 | 10.8 | 21.6 | 32.4 | 43.2 | 54.0 | 64.8 | 75.6 | 86.4 | 97.2 | 108.0 | 118.8 | 129.6 | 10.80 |
| 10.85 | 10.9 | 21.7 | 32.6 | 43.4 | 54.3 | 65.1 | 76.0 | 86.8 | 97.7 | 108.5 | 119.4 | 130.2 | 10.85 |
| 10.90 | 10.9 | 21.8 | 32.7 | 43.6 | 54.5 | 65.4 | 76.3 | 87.2 | 98.1 | 109.0 | 119.9 | 130.8 | 10.90 |
| 10.95 | 11.0 | 21.9 | 32.9 | 43.8 | 54.8 | 65.7 | 76.7 | 87.6 | 98.6 | 109.5 | 120.5 | 131.4 | 10.95 |
| 11.00 | 11.0 | 22.0 | 33.0 | 44.0 | 55.0 | 66.0 | 77.0 | 88.0 | 99.0 | 110.0 | 121.0 | 132.0 | 11.00 |
| 11.05 | 11.1 | 22.1 | 33.2 | 44.2 | 55.3 | 66.3 | 77.4 | 88.4 | 99.5 | 110.5 | 121.6 | 132.6 | 11.05 |
| 11.10 | 11.1 | 22.2 | 33.3 | 44.4 | 55.5 | 66.6 | 77.7 | 88.8 | 99.9 | 111.0 | 122.1 | 133.2 | 11.10 |
| 11.15 | 11.2 | 22.3 | 33.5 | 44.6 | 55.8 | 66.9 | 78.1 | 89.2 | 100.4 | 111.5 | 122.7 | 133.8 | 11.15 |
| 11.20 | 11.2 | 22.4 | 33.6 | 44.8 | 56.0 | 67.2 | 78.4 | 89.6 | 100.8 | 112.0 | 123.2 | 134.4 | 11.20 |
| 11.25 | 11.3 | 22.5 | 33.8 | 45.0 | 56.3 | 67.5 | 78.8 | 90.0 | 101.3 | 112.5 | 123.8 | 135.0 | 11.25 |
| 11.30 | 11.3 | 22.6 | 33.9 | 45.2 | 56.5 | 67.8 | 79.1 | 90.4 | 101.7 | 113.0 | 124.3 | 135.6 | 11.30 |
| 11.35 | 11.4 | 22.7 | 34.1 | 45.4 | 56.8 | 68.1 | 79.5 | 90.8 | 102.2 | 113.5 | 124.9 | 136.2 | 11.35 |
| 11.40 | 11.4 | 22.8 | 34.2 | 45.6 | 57.0 | 68.4 | 79.8 | 91.2 | 102.6 | 114.0 | 125.4 | 136.8 | 11.40 |
| 11.45 | 11.5 | 22.9 | 34.4 | 45.8 | 57.3 | 68.7 | 80.2 | 91.6 | 103.1 | 114.5 | 126.0 | 137.4 | 11.45 |

TABLE 13. [Page 521

For finding the Sun's change of Right Ascension for any given number of hours.

| Hourly varia-tion. | Number of hours. | | | | | | | | | | | | Hourly varia-tion. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | |
| *s.* 8.50 | *s.* 110.5 | *s.* 119.0 | *s.* 127.5 | *s.* 136.0 | *s.* 144.5 | *s.* 153.0 | *s.* 161.5 | *s.* 170.0 | *s.* 178.5 | *s.* 187.0 | *s,* 195.5 | *s.* 204.0 | *s.* 8.50 |
| 8.55 | 111.2 | 119.7 | 128.3 | 136.8 | 145.4 | 153.9 | 162.5 | 171.0 | 179.6 | 188.1 | 196.7 | 205.2 | 8.55 |
| 8.60 | 111.8 | 120.4 | 129.0 | 137.6 | 146.2 | 154.8 | 163.4 | 172.0 | 180.6 | 189.2 | 197.8 | 206.4 | 8.60 |
| 8.65 | 112.5 | 121.1 | 129.8 | 138.4 | 147.1 | 155.7 | 164.4 | 173.0 | 181.7 | 190.3 | 199.0 | 207.6 | 8.65 |
| 8.70 | 113.1 | 121.8 | 130.5 | 139.2 | 147.9 | 156.6 | 165.3 | 174.0 | 182.7 | 191.4 | 200.1 | 208.8 | 8.70 |
| 8.75 | 113.8 | 122.5 | 131.3 | 140.0 | 148.8 | 157.5 | 166.3 | 175.0 | 183.8 | 192.5 | 201.3 | 210.0 | 8.75 |
| 8.80 | 114.4 | 123.2 | 132.0 | 140.8 | 149.6 | 158.4 | 167.2 | 176.0 | 184.8 | 193.6 | 202.4 | 211.2 | 8.80 |
| 8.85 | 115.1 | 123.9 | 132.8 | 141.6 | 150.5 | 159.3 | 168.2 | 177.0 | 185.9 | 194.7 | 203.6 | 212.4 | 8.85 |
| 8.90 | 115.7 | 124.6 | 133.5 | 142.4 | 151.3 | 160.2 | 169.1 | 178.0 | 186.9 | 195.8 | 204.7 | 213.6 | 8.90 |
| 8.95 | 116.4 | 125.3 | 134.3 | 143.2 | 152.2 | 161.1 | 170.1 | 179.0 | 188.0 | 196.9 | 205.9 | 214.8 | 8.95 |
| 9.00 | 117.0 | 126.0 | 135.0 | 144.0 | 153.0 | 162.0 | 171.0 | 180.0 | 189.0 | 198.0 | 207.0 | 216.0 | 9.00 |
| 9.05 | 117.7 | 126.7 | 135.8 | 144.8 | 153.9 | 162.9 | 172.0 | 181.0 | 190.1 | 199.1 | 208.2 | 217.2 | 9.05 |
| 9.10 | 118.3 | 127.4 | 136.5 | 145.6 | 154.7 | 163.8 | 172.9 | 182.0 | 191.1 | 200.2 | 209.3 | 218.4 | 9.10 |
| 9.15 | 119.0 | 128.1 | 137.3 | 146.4 | 155.6 | 164.7 | 173.9 | 183.0 | 192.2 | 201.3 | 210.5 | 219.6 | 9.15 |
| 9.20 | 119.6 | 128.8 | 138.0 | 147.2 | 156.4 | 165.6 | 174.8 | 184.0 | 193.2 | 202.4 | 211.6 | 220.8 | 9.20 |
| 9.25 | 120.3 | 129.5 | 138.8 | 148.0 | 157.3 | 166.5 | 175.8 | 185.0 | 194.3 | 203.5 | 212.8 | 222.0 | 9.25 |
| 9.30 | 120.9 | 130.2 | 139.5 | 148.8 | 158.1 | 167.4 | 176.7 | 186.0 | 195.3 | 204.6 | 213.9 | 223.2 | 9.30 |
| 9.35 | 121.6 | 130.9 | 140.3 | 149.6 | 159.0 | 168.3 | 177.7 | 187.0 | 196.4 | 205.7 | 215.1 | 224.4 | 9.35 |
| 9.40 | 122.2 | 131.6 | 141.0 | 150.4 | 159.8 | 169.2 | 178.6 | 188.0 | 197.4 | 206.8 | 216.2 | 225.6 | 9.40 |
| 9.45 | 122.9 | 132.3 | 141.8 | 151.2 | 160.7 | 170.1 | 179.6 | 189.0 | 198.5 | 207.9 | 217.4 | 226.8 | 9.45 |
| 9.50 | 123.5 | 133.0 | 142.5 | 152.0 | 161.5 | 171.0 | 180.5 | 190.0 | 199.5 | 209.0 | 218.5 | 228.0 | 9.50 |
| 9.55 | 124.2 | 133.7 | 143.3 | 152.8 | 162.4 | 171.9 | 181.5 | 191.0 | 200.6 | 210.1 | 219.7 | 229.2 | 9.55 |
| 9.60 | 124.8 | 134.4 | 144.0 | 153.6 | 163.2 | 172.8 | 182.4 | 192.0 | 201.6 | 211.2 | 220.8 | 230.4 | 9.60 |
| 9.65 | 125.5 | 135.1 | 144.8 | 154.4 | 164.1 | 173.7 | 183.4 | 193.0 | 202.7 | 212.3 | 222.0 | 231.6 | 9.65 |
| 9.70 | 126.1 | 135.8 | 145.5 | 155.2 | 164.9 | 174.6 | 184.3 | 194.0 | 203.7 | 213.4 | 223.1 | 232.8 | 9.70 |
| 9.75 | 126.8 | 136.5 | 146.3 | 156.0 | 165.8 | 175.5 | 185.3 | 195.0 | 204.8 | 214.5 | 224.3 | 234.0 | 9.75 |
| 9.80 | 127.4 | 137.2 | 147.0 | 156.8 | 166.6 | 176.4 | 186.2 | 196.0 | 205.8 | 215.6 | 225.4 | 235.2 | 9.80 |
| 9.85 | 128.1 | 137.9 | 147.8 | 157.6 | 167.5 | 177.3 | 187.2 | 197.0 | 206.9 | 216.7 | 226.6 | 236.4 | 9.85 |
| 9.90 | 128.7 | 138.6 | 148.5 | 158.4 | 168.3 | 178.2 | 188.1 | 198.0 | 207.9 | 217.8 | 227.7 | 237.6 | 9.90 |
| 9.95 | 129.4 | 139.3 | 149.3 | 159.2 | 169.2 | 179.1 | 189.1 | 199.0 | 209.0 | 218.9 | 228.9 | 238.8 | 9.95 |
| 10.00 | 130.0 | 140.0 | 150.0 | 160.0 | 170.0 | 180.0 | 190.0 | 200.0 | 210.0 | 220.0 | 230.0 | 240.0 | 10.00 |
| 10.05 | 130.7 | 140.7 | 150.8 | 160.8 | 170.9 | 180.9 | 191.0 | 201.0 | 211.1 | 221.1 | 231.2 | 241.2 | 10.05 |
| 10.10 | 131.3 | 141.4 | 151.5 | 161.6 | 171.7 | 181.8 | 191.9 | 202.0 | 212.1 | 222.2 | 232.3 | 242.4 | 10.10 |
| 10.15 | 132.0 | 142.1 | 152.3 | 162.4 | 172.6 | 182.7 | 192.9 | 203.0 | 213.2 | 223.3 | 233.5 | 243.6 | 10.15 |
| 10.20 | 132.6 | 142.8 | 153.0 | 163.2 | 173.4 | 183.6 | 193.8 | 204.0 | 214.2 | 224.4 | 234.6 | 244.8 | 10.20 |
| 10.25 | 133.3 | 143.5 | 153.8 | 164.0 | 174.3 | 184.5 | 194.8 | 205.0 | 215.3 | 225.5 | 235.8 | 246.0 | 10.25 |
| 10.30 | 133.9 | 144.2 | 154.5 | 164.8 | 175.1 | 185.4 | 195.7 | 206.0 | 216.3 | 226.6 | 236.9 | 247.2 | 10.30 |
| 10.35 | 134.6 | 144.9 | 155.3 | 165.6 | 176.0 | 186.3 | 196.7 | 207.0 | 217.4 | 227.7 | 238.1 | 248.4 | 10.35 |
| 10.40 | 135.2 | 145.6 | 156.0 | 166.4 | 176.8 | 187.2 | 197.6 | 208.0 | 218.4 | 228.8 | 239.2 | 249.6 | 10.40 |
| 10.45 | 135.9 | 146.3 | 156.8 | 167.2 | 177.7 | 188.1 | 198.6 | 209.0 | 219.5 | 229.9 | 240.4 | 250.8 | 10.45 |
| 10.50 | 136.5 | 147.0 | 157.5 | 168.0 | 178.5 | 189.0 | 199.5 | 210.0 | 220.5 | 231.0 | 241.5 | 252.0 | 10.50 |
| 10.55 | 137.2 | 147.7 | 158.3 | 168.8 | 179.4 | 189.9 | 200.5 | 211.0 | 221.6 | 232.1 | 242.7 | 253.2 | 10.55 |
| 10.60 | 137.8 | 148.4 | 159.0 | 169.6 | 180.2 | 190.8 | 201.4 | 212.0 | 222.6 | 233.2 | 243.8 | 254.4 | 10.60 |
| 10.65 | 138.5 | 149.1 | 159.8 | 170.4 | 181.1 | 191.7 | 202.4 | 213.0 | 223.7 | 234.3 | 245.0 | 255.6 | 10.65 |
| 10.70 | 139.1 | 149.8 | 160.5 | 171.2 | 181.9 | 192.6 | 203.3 | 214.0 | 224.7 | 235.4 | 246.1 | 256.8 | 10.70 |
| 10.75 | 139.8 | 150.5 | 161.3 | 172.0 | 182.8 | 193.5 | 204.3 | 215.0 | 225.8 | 236.5 | 247.3 | 258.0 | 10.75 |
| 10.80 | 140.4 | 151.2 | 162.0 | 172.8 | 183.6 | 194.4 | 205.2 | 216.0 | 226.8 | 237.6 | 248.4 | 259.2 | 10.80 |
| 10.85 | 141.1 | 151.9 | 162.8 | 173.6 | 184.5 | 195.3 | 206.2 | 217.0 | 227.9 | 238.7 | 249.6 | 260.4 | 10.85 |
| 10.90 | 141.7 | 152.6 | 163.5 | 174.4 | 185.3 | 196.2 | 207.1 | 218.0 | 228.9 | 239.8 | 250.7 | 261.6 | 10.90 |
| 10.95 | 142.4 | 153.3 | 164.3 | 175.2 | 186.2 | 197.1 | 208.1 | 219.0 | 230.0 | 240.9 | 251.9 | 262.8 | 10.95 |
| 11.00 | 143.0 | 154.0 | 165.0 | 176.0 | 187.0 | 198.0 | 209.0 | 220.0 | 231.0 | 242.0 | 253.0 | 264.0 | 11.00 |
| 11.05 | 143.7 | 154.7 | 165.8 | 176.8 | 187.9 | 198.9 | 210.0 | 221.0 | 232.1 | 243.1 | 254.2 | 265.2 | 11.05 |
| 11.10 | 144.3 | 155.4 | 166.5 | 177.6 | 188.7 | 199.8 | 210.9 | 222.0 | 233.1 | 244.2 | 255.3 | 266.4 | 11.10 |
| 11.15 | 145.0 | 156.1 | 167.3 | 178.4 | 189.6 | 200.7 | 211.9 | 223.0 | 234.2 | 245.3 | 256.5 | 267.6 | 11.15 |
| 11.20 | 145.6 | 156.8 | 168.0 | 179.2 | 190.4 | 201.6 | 212.8 | 224.0 | 235.2 | 246.4 | 257.6 | 268.8 | 11.20 |
| 11.25 | 146.3 | 157.5 | 168.8 | 180.0 | 191.3 | 202.5 | 213.8 | 225.0 | 236.3 | 247.5 | 258.8 | 270.0 | 11.25 |
| 11.30 | 146.9 | 158.2 | 169.5 | 180.8 | 192.1 | 203.4 | 214.7 | 226.0 | 237.3 | 248.6 | 259.9 | 271.2 | 11.30 |
| 11.35 | 147.6 | 158.9 | 170.3 | 181.6 | 193.0 | 204.3 | 215.7 | 227.0 | 238.4 | 249.7 | 261.1 | 272.4 | 11.35 |
| 11.40 | 148.2 | 159.6 | 171.0 | 182.4 | 193.8 | 205.2 | 216.6 | 228.0 | 239.4 | 250.8 | 262.2 | 273.6 | 11.40 |
| 11.45 | 148.9 | 160.3 | 171.8 | 183.2 | 194.7 | 206.1 | 217.6 | 229.0 | 240.5 | 251.9 | 263.4 | 274.8 | 11.45 |

## TABLE 14.

### Dip of the Sea Horizon.

| Height of the Eye. | Dip of the Horizon. |
|---|---|
| Feet. | ′ ″ |
| 1 | 0 59 |
| 2 | 1 23 |
| 3 | 1 42 |
| 4 | 1 58 |
| 5 | 2 11 |
| 6 | 2 24 |
| 7 | 2 36 |
| 8 | 2 46 |
| 9 | 2 56 |
| 10 | 3 06 |
| 11 | 3 15 |
| 12 | 3 24 |
| 13 | 3 32 |
| 14 | 3 40 |
| 15 | 3 48 |
| 16 | 3 55 |
| 17 | 4 02 |
| 18 | 4 09 |
| 19 | 4 16 |
| 20 | 4 23 |
| 21 | 4 29 |
| 22 | 4 36 |
| 23 | 4 42 |
| 24 | 4 48 |
| 25 | 4 54 |
| 26 | 5 00 |
| 27 | 5 06 |
| 28 | 5 11 |
| 29 | 5 17 |
| 30 | 5 22 |
| 31 | 5 27 |
| 32 | 5 33 |
| 33 | 5 38 |
| 34 | 5 43 |
| 35 | 5 48 |
| 36 | 5 53 |
| 37 | 5 58 |
| 38 | 6 02 |
| 39 | 6 07 |
| 40 | 6 12 |
| 45 | 6 36 |
| 50 | 6 56 |
| 55 | 7 16 |
| 60 | 7 35 |
| 65 | 7 54 |
| 70 | 8 12 |
| 75 | 8 29 |
| 80 | 8 46 |
| 85 | 9 02 |
| 90 | 9 18 |
| 95 | 9 33 |
| 100 | 9 48 |

## TABLE 15.

### Dip of the Sea at different Distances from the Observer.

| Dist. of Land in Sea Miles. | Height of the Eye above the Sea in Feet. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
| | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| ¼ | 11 | 23 | 34 | 45 | 57 | 68 | 79 | 91 |
| ½ | 6 | 12 | 17 | 23 | 28 | 34 | 40 | 45 |
| ¾ | 4 | 8 | 12 | 15 | 19 | 23 | 27 | 30 |
| 1 | 3 | 6 | 9 | 12 | 15 | 17 | 20 | 23 |
| 1¼ | 3 | 5 | 7 | 10 | 12 | 14 | 16 | 19 |
| 1½ | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
| 2 | 2 | 4 | 5 | 7 | 8 | 9 | 11 | 12 |
| 2½ | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 10 |
| 3 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 3½ | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 |
| 4 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 7 |
| 5 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 |
| 6 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 6 |

NOTE TO TABLE 15.—The numbers of this Table below the black lines are the same as are given in Table 14, the visible horizon corresponding to those heights not being so far distant as the land.

## TABLE 16.

### The Sun's Parallax in Altitude.

| Altitude. | Parallax. |
|---|---|
| ° | ″ |
| 0 | 9 |
| 10 | 9 |
| 20 | 8 |
| 30 | 8 |
| 40 | 7 |
| 50 | 6 |
| 55 | 5 |
| 60 | 4 |
| 65 | 4 |
| 70 | 3 |
| 75 | 2 |
| 80 | 2 |
| 85 | 1 |
| 90 | 0 |

# TABLE 17.

### Parallax in Altitude of a Planet.

Horizontal parallax of planet.

| Altitude | 35″ | 30″ | 28″ | 27″ | 26″ | 25″ | 24″ | 23″ | 22″ | 21″ | 20″ | 19″ | 18″ | 17″ | 16″ | 15″ | 14″ | 13″ | 12″ | 11″ | 10″ | 9″ | 8″ | 7″ | 6″ | 5″ | 4″ | 3″ | 2″ | 1″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 35 | 30 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 5 | 35 | 30 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 10 | 34 | 30 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 20 | 33 | 28 | 26 | 25 | 24 | 23 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 30 | 30 | 26 | 24 | 23 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 3 | 2 | 1 |
| 35 | 29 | 25 | 23 | 22 | 21 | 20 | 20 | 19 | 18 | 17 | 16 | 16 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 9 | 8 | 7 | 7 | 6 | 5 | 4 | 3 | 2 | 2 | 1 |
| 40 | 27 | 23 | 21 | 21 | 20 | 19 | 18 | 18 | 17 | 16 | 15 | 15 | 14 | 13 | 12 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 6 | 5 | 5 | 4 | 3 | 2 | 2 | 1 |
| 43 | 26 | 22 | 20 | 20 | 19 | 18 | 18 | 17 | 16 | 15 | 15 | 14 | 13 | 12 | 12 | 11 | 10 | 10 | 9 | 8 | 7 | 7 | 6 | 5 | 4 | 4 | 3 | 2 | 1 | 1 |
| 46 | 24 | 21 | 19 | 19 | 18 | 17 | 17 | 16 | 15 | 15 | 14 | 13 | 13 | 12 | 11 | 10 | 10 | 9 | 8 | 8 | 7 | 6 | 6 | 5 | 4 | 3 | 3 | 2 | 1 | 1 |
| 49 | 23 | 20 | 18 | 18 | 17 | 16 | 16 | 15 | 14 | 14 | 13 | 12 | 12 | 11 | 10 | 10 | 9 | 9 | 8 | 7 | 7 | 6 | 5 | 5 | 4 | 3 | 3 | 2 | 1 | 1 |
| 52 | 22 | 18 | 17 | 17 | 16 | 15 | 15 | 14 | 14 | 13 | 12 | 12 | 11 | 10 | 10 | 9 | 9 | 8 | 7 | 7 | 6 | 6 | 5 | 4 | 4 | 3 | 2 | 2 | 1 | 1 |
| 55 | 20 | 17 | 16 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 3 | 3 | 2 | 2 | 1 | 1 |
| 58 | 19 | 16 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 |
| 61 | 17 | 15 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 0 |
| 64 | 15 | 13 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 0 |
| 67 | 14 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 0 |
| 70 | 12 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 0 |
| 72 | 11 | 9 | 9 | 8 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 |
| 74 | 10 | 8 | 8 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 |
| 76 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 0 |
| 78 | 7 | 6 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 80 | 6 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 82 | 5 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 84 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 86 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 88 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Altitude.

| TABLE 18. | | | | | | TABLE 19. | | | |
|---|---|---|---|---|---|---|---|---|---|

Augmentation of the Moon's Semidiameter.  |  Augmentation of the Moon's Horizontal Parallax.

| Apparent altitude of ☽ | ☽'s Semidiameter. | | | | | | Latitude of observation. | ☽'s Hor. Parallax. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 14′ | 15′ | | 16′ | | 17′ | | 53′ | 57′ | 61′ |
| | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | | | | |
| ° | ″ | ″ | ″ | ″ | ″ | ″ | ° | ″ | ″ | ″ |
| 0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | 2 | 0.0 | 0.0 | 0.0 |
| 4 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 4 | 0.1 | 0.1 | 0.1 |
| 6 | 1.5 | 1.6 | 1.7 | 1.9 | 2.0 | 2.1 | 6 | 0.1 | 0.1 | 0.1 |
| 8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 | 8 | 0.2 | 0.2 | 0.2 |
| 10 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 10 | 0.3 | 0.3 | 0.4 |
| 12 | 2.9 | 3.1 | 3.3 | 3.6 | 3.8 | 4.0 | 12 | 0.5 | 0.5 | 0.5 |
| 14 | 3.4 | 3.6 | 3.9 | 4.1 | 4.4 | 4.7 | 14 | 0.6 | 0.7 | 0.7 |
| 16 | 3.8 | 4.1 | 4.4 | 4.7 | 5.0 | 5.3 | 16 | 0.8 | 0.9 | 0.9 |
| 18 | 4.3 | 4.6 | 4.9 | 5.2 | 5.6 | 5.9 | 18 | 1.0 | 1.1 | 1.1 |
| 20 | 4.7 | 5.1 | 5.4 | 5.8 | 6.1 | 6.5 | 20 | 1.2 | 1.3 | 1.4 |
| 22 | 5.2 | 5.5 | 5.9 | 6.3 | 6.7 | 7.1 | 22 | 1.5 | 1.6 | 1.7 |
| 24 | 5.6 | 6.0 | 6.4 | 6.8 | 7.3 | 7.7 | 24 | 1.7 | 1.9 | 2.0 |
| 26 | 6.0 | 6.5 | 6.9 | 7.4 | 7.8 | 8.3 | 26 | 2.0 | 2.2 | 2.3 |
| 28 | 6.5 | 6.9 | 7.4 | 7.9 | 8.4 | 8.9 | 28 | 2.3 | 2.5 | 2.6 |
| 30 | 6.9 | 7.3 | 7.9 | 8.4 | 8.9 | 9.5 | 30 | 2.6 | 2.8 | 3.0 |
| 32 | 7.3 | 7.8 | 8.3 | 8.9 | 9.4 | 10.0 | 32 | 2.9 | 3.1 | 3.4 |
| 34 | 7.7 | 8.2 | 8.8 | 9.4 | 10.0 | 10.6 | 34 | 3.3 | 3.5 | 3.8 |
| 36 | 8.1 | 8.6 | 9.2 | 9.8 | 10.5 | 11.1 | 36 | 3.6 | 3.9 | 4.1 |
| 38 | 8.4 | 9.0 | 9.7 | 10.3 | 10.9 | 11.6 | 38 | 4.0 | 4.3 | 4.6 |
| 40 | 8.8 | 9.4 | 10.1 | 10.7 | 11.4 | 12.1 | 40 | 4.3 | 4.6 | 5.0 |
| 42 | 9.2 | 9.8 | 10.5 | 11.2 | 11.9 | 12.6 | 42 | 4.7 | 5.0 | 5.4 |
| 44 | 9.5 | 10.2 | 10.9 | 11.6 | 12.3 | 13.1 | 44 | 5.0 | 5.4 | 5.8 |
| 46 | 9.8 | 10.5 | 11.3 | 12.0 | 12.8 | 13.6 | 46 | 5.4 | 5.8 | 6.2 |
| 48 | 10.2 | 10.9 | 11.6 | 12.4 | 13.2 | 14.0 | 48 | 5.8 | 6.2 | 6.6 |
| 50 | 10.5 | 11.2 | 12.0 | 12.8 | 13.6 | 14.4 | 50 | 6.1 | 6.6 | 7.1 |
| 52 | 10.8 | 11.5 | 12.3 | 13.1 | 14.0 | 14.9 | 52 | 6.5 | 7.0 | 7.5 |
| 54 | 11.1 | 11.8 | 12.7 | 13.5 | 14.4 | 15.3 | 54 | 6.8 | 7.4 | 7.9 |
| 56 | 11.3 | 12.1 | 13.0 | 13.8 | 14.7 | 15.6 | 56 | 7.2 | 7.7 | 8.3 |
| 58 | 11.6 | 12.4 | 13.3 | 14.1 | 15.1 | 16.0 | 58 | 7.5 | 8.1 | 8.6 |
| 60 | 11.8 | 12.7 | 13.5 | 14.4 | 15.4 | 16.3 | 60 | 7.8 | 8.4 | 9.0 |
| 62 | 12.1 | 12.9 | 13.8 | 14.7 | 15.7 | 16.6 | 62 | 8.1 | 8.8 | 9.4 |
| 64 | 12.3 | 13.2 | 14.1 | 15.0 | 16.0 | 16.9 | 64 | 8.4 | 9.1 | 9.7 |
| 66 | 12.5 | 13.4 | 14.3 | 15.2 | 16.2 | 17.2 | 66 | 8.7 | 9.4 | 10.0 |
| 68 | 12.7 | 13.6 | 14.5 | 15.5 | 16.5 | 17.5 | 68 | 9.0 | 9.7 | 10.3 |
| 70 | 12.9 | 13.8 | 14.7 | 15.7 | 16.7 | 17.7 | 70 | 9.2 | 9.9 | 10.6 |
| 72 | 13.0 | 13.9 | 14.9 | 15.9 | 16.9 | 17.9 | 72 | 9.5 | 10.2 | 10.9 |
| 74 | 13.1 | 14.1 | 15.0 | 16.0 | 17.1 | 18.1 | 74 | 9.7 | 10.4 | 11.1 |
| 76 | 13.3 | 14.2 | 15.2 | 16.2 | 17.2 | 18.3 | 76 | 9.8 | 10.6 | 11.3 |
| 78 | 13.4 | 14.3 | 15.3 | 16.3 | 17.4 | 18.4 | 78 | 10.0 | 10.8 | 11.5 |
| 80 | 13.5 | 14.4 | 15.4 | 16.4 | 17.5 | 18.6 | 80 | 10.1 | 10.9 | 11.7 |
| 82 | 13.5 | 14.5 | 15.5 | 16.5 | 17.6 | 18.7 | 82 | 10.3 | 11.0 | 11.8 |
| 84 | 13.6 | 14.6 | 15.6 | 16.6 | 17.6 | 18.7 | 84 | 10.3 | 11.1 | 11.9 |
| 86 | 13.6 | 14.6 | 15.6 | 16.6 | 17.7 | 18.8 | 86 | 10.4 | 11.2 | 12.0 |
| 88 | 13.7 | 14.6 | 15.6 | 16.7 | 17.7 | 18.8 | 88 | 10.4 | 11.2 | 12.0 |
| 90 | 13.7 | 14.6 | 15.6 | 16.7 | 17.7 | 18.8 | 90 | 10.5 | 11.3 | 12.0 |

## Mean Refraction.

[Barometer, 30 inches.  Fahrenheit's Thermometer, 50°.]

| Apparent Altitude. | Mean Refraction. | Apparent Altitude. | Mean Refraction. | Apparent Altitude. | Mean Refraction. | Apparent Altitude. | Mean Refraction. | Apparent Altitude. | Mean Refraction. |
|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ |
|  |  | 9 30 | 5 35.1 | 15 00 | 3 34.1 | 25 00 | 2 4.4 | 42 00 | 1 04.7 |
| 0 00 | 36 29.4 | 35 | 5 32.4 | 10 | 3 31.7 | 10 | 2 3.4 | 20 | 1 03.9 |
| 1 00 | 24 53.6 | 40 | 5 29.6 | 20 | 3 29.4 | 20 | 2 2.5 | 40 | 1 03.2 |
| 2 00 | 18 25.5 | 45 | 5 27.0 | 30 | 3 27.1 | 30 | 2 1.6 | 43 00 | 1 02.4 |
| 3 00 | 14 25.1 | 50 | 5 24.3 | 40 | 3 24.8 | 40 | 2 0.7 | 20 | 1 01.7 |
| 4 00 | 11 44.4 | 55 | 5 21.7 | 50 | 3 22.6 | 50 | 1 59.8 | 40 | 1 01.0 |
| 5 00 | 9 52.0 | 10 00 | 5 19.2 | 16 00 | 3 20.5 | 26 00 | 1 58.9 | 44 00 | 1 00.3 |
| 05 | 9 44.0 | 05 | 5 16.7 | 10 | 3 18.4 | 10 | 1 58.1 | 20 | 0 59.6 |
| 10 | 9 36.2 | 10 | 5 14.2 | 20 | 3 16.3 | 20 | 1 57.2 | 40 | 0 58.9 |
| 15 | 9 28.6 | 15 | 5 11.7 | 30 | 3 14.2 | 30 | 1 56.4 | 45 00 | 0 58.2 |
| 20 | 9 21.2 | 20 | 5 9.3 | 40 | 3 12.2 | 40 | 1 55.5 | 20 | 0 57.6 |
| 25 | 9 14.0 | 25 | 5 6.9 | 50 | 3 10.3 | 50 | 1 54.7 | 40 | 0 56.9 |
| 5 30 | 9 7.0 | 10 30 | 5 4.6 | 17 00 | 3 8.3 | 27 00 | 1 53.9 | 46 00 | 0 56.2 |
| 35 | 9 0.1 | 35 | 5 2.3 | 10 | 3 6.4 | 10 | 1 53.1 | 20 | 0 55.6 |
| 40 | 8 53.4 | 40 | 5 0.0 | 20 | 3 4.6 | 20 | 1 52.3 | 40 | 0 55.0 |
| 45 | 8 46.8 | 45 | 4 57.8 | 30 | 3 2.8 | 30 | 1 51.5 | 47 00 | 0 54.3 |
| 50 | 8 40.4 | 50 | 4 55.6 | 40 | 3 1.0 | 40 | 1 50.7 | 20 | 0 53.7 |
| 55 | 8 34.2 | 55 | 4 53.4 | 50 | 2 59.2 | 50 | 1 50.0 | 40 | 0 53.1 |
| 6 00 | 8 28.0 | 11 00 | 4 51.2 | 18 00 | 2 57.5 | 28 00 | 1 49.2 | 48 00 | 0 52.5 |
| 05 | 8 22.1 | 05 | 4 49.1 | 10 | 2 55.8 | 20 | 1 47.7 | 49 00 | 0 50.6 |
| 10 | 8 16.2 | 10 | 4 47.0 | 20 | 2 54.1 | 40 | 1 46.2 | 50 00 | 0 48.9 |
| 15 | 8 10.5 | 15 | 4 44.9 | 30 | 2 52.4 | 29 00 | 1 44.8• | 51 00 | 0 47.2 |
| 20 | 8 4.8 | 20 | 4 42.9 | 40 | 2 50.8 | 20 | 1 43.4 | 52 00 | 0 45.5 |
| 25 | 7 59.3 | 25 | 4 40.9 | 50 | 2 49.2 | 40 | 1 42.0 | 53 00 | 0 43.9 |
| 6 30 | 7 53.9 | 11 30 | 4 38.9 | 19 00 | 2 47.7 | 30 00 | 1 40.6 | 54 00 | 0 42.3 |
| 35 | 7 48.7 | 35 | 4 36.9 | 10 | 2 46.1 | 20 | 1 39.3 | 55 00 | 0 40.8 |
| 40 | 7 43.5 | 40 | 4 35.0 | 20 | 2 44.6 | 40 | 1 38.0 | 56 00 | 0 39.3 |
| 45 | 7 38.4 | 45 | 4 33.1 | 30 | 2 43.1 | 31 00 | 1 36.7 | 57 00 | 0 37.8 |
| 50 | 7 33.5 | 50 | 4 31.2 | 40 | 2 41.6 | 20 | 1 35.5 | 58 00 | 0 36.4 |
| 55 | 7 28.6 | 55 | 4 29.4 | 50 | 2 40.2 | 40 | 1 34.2 | 59 00 | 0 35.0 |
| 7 00 | 7 23.8 | 12 00 | 4 27.5 | 20 00 | 2 38.8 | 32 00 | 1 33.0 | 60 00 | 0 33.6 |
| 05 | 7 19.2 | 05 | 4 25.7 | 10 | 2 37.4 | 20 | 1 31.8 | 61 00 | 0 32.3 |
| 10 | 7 14.6 | 10 | 4 23.9 | 20 | 2 36.0 | 40 | 1 30.7 | 62 00 | 0 31.0 |
| 15 | 7 10.1 | 15 | 4 22.2 | 30 | 2 34.6 | 33 00 | 1 29.5 | 63 00 | 0 29.7 |
| 20 | 7 5.7 | 20 | 4 20.4 | 40 | 2 33.3 | 20 | 1 28.4 | 64 00 | 0 28.4 |
| 25 | 7 1.4 | 25 | 4 18.7 | 50 | 2 32.0 | 40 | 1 27.3 | 65 00 | 0 27.2 |
| 7 30 | 6 57.1 | 12 30 | 4 17.0 | 21 00 | 2 30.7 | 34 00 | 1 26.2 | 66 00 | 0 25.9 |
| 35 | 6 53.0 | 35 | 4 15.3 | 10 | 2 29.4 | 20 | 1 25.1 | 67 00 | 0 24.7 |
| 40 | 6 48.9 | 40 | 4 13.6 | 20 | 2 28.1 | 40 | 1 24.1 | 68 00 | 0 23.6 |
| 45 | 6 44.9 | 45 | 4 12.0 | 30 | 2 26.9 | 35 00 | 1 23.1 | 69 00 | 0 22.4 |
| 50 | 6 41.0 | 50 | 4 10.4 | 40 | 2 25.7 | 20 | 1 22.0 | 70 00 | 0 21.2 |
| 55 | 6 37.1 | 55 | 4 8.8 | 50 | 2 24.5 | 40 | 1 21.0 | 71 00 | 0 20.1 |
| 8 00 | 6 33.3 | 13 00 | 4 7.2 | 22 00 | 2 23.3 | 36 00 | 1 20.1 | 72 00 | 0 18.9 |
| 05 | 6 29.6 | 05 | 4 5.6 | 10 | 2 22.1 | 20 | 1 19.1 | 73 00 | 0 17.8 |
| 10 | 6 25.9 | 10 | 4 4.1 | 20 | 2 20.9 | 40 | 1 18.2 | 74 00 | 0 16.7 |
| 15 | 6 22.3 | 15 | 4 2.6 | 30 | 2 19.8 | 37 00 | 1 17.2 | 75 00 | 0 15.6 |
| 20 | 6 18.8 | 20 | 4 1.0 | 40 | 2 18.7 | 20 | 1 16.3 | 76 00 | 0 14.5 |
| 25 | 6 15.3 | 25 | 3 59.6 | 50 | 2 17.5 | 40 | 1 15.4 | 77 00 | 0 13.5 |
| 8 30 | 6 11.9 | 13 30 | 3 58.1 | 23 00 | 2 16.4 | 38 00 | 1 14.5 | 78 00 | 0 12.4 |
| 35 | 6 8.5 | 35 | 3 56.6 | 10 | 2 15.4 | 20 | 1 13.6 | 79 00 | 0 11.3 |
| 40 | 6 5.2 | 40 | 3 55.2 | 20 | 2 14.3 | 40 | 1 12.7 | 80 00 | 0 10.3 |
| 45 | 6 2.0 | 45 | 3 53.7 | 30 | 2 13.3 | 39 00 | 1 11.9 | 81 00 | 0 9.2 |
| 50 | 5 58.8 | 50 | 3 52.3 | 40 | 2 12.2 | 20 | 1 11.0 | 82 00 | 0 8.2 |
| 55 | 5 55.7 | 55 | 3 50.9 | 50 | 2 11.2 | 40 | 1 10.2 | 83 00 | 0 7.2 |
| 9 00 | 5 52.6 | 14 00 | 3 49.5 | 24 00 | 2 10.2 | 40 00 | 1 9.4 | 84 00 | 0 6.1 |
| 05 | 5 49.6 | 10 | 3 46.8 | 10 | 2 9.2 | 20 | 1 8.6 | 85 00 | 0 5.1 |
| 10 | 5 46.6 | 20 | 3 44.2 | 20 | 2 8.2 | 40 | 1 7.8 | 86 00 | 0 4.1 |
| 15 | 5 43.6 | 30 | 3 41.6 | 30 | 2 7.2 | 41 00 | 1 7.0 | 87 00 | 0 3.1 |
| 20 | 5 40.7 | 40 | 3 39.0 | 40 | 2 6.2 | 20 | 1 6.2 | 88 00 | 0 2.0 |
| 25 | 5 37.9 | 50 | 3 36.5 | 50 | 2 5.3 | 40 | 1 5.4 | 89 00 | 0 1.0 |
| 9 30 | 5 35.1 | 15 00 | 3 34.1 | 25 00 | 2 4.4 | 42 00 | 1 4.7 | 90 00 | 0 0.0 |

# TABLE 20B.

### Correction of the Sun's Apparent Altitude for Refraction and Parallax.

[Barometer, 30 inches.   Fahrenheit's Thermometer, 50°.]

| Apparent Altitude. | Mean Refraction and Parallax ⊙. | Apparent Altitude. | Mean Refraction and Parallax ⊙. | Apparent Altitude. | Mean Refraction and Parallax ⊙. | Apparent Altitude. | Mean Refraction and Parallax ⊙. | Apparent Altitude. | Mean Refraction and Parallax ⊙. |
|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ | ° ′ | ′ ″ |
| | | 9 30 | 5 26 | 15 00 | 3 25 | 25 00 | 1 56 | 42 00 | 0 58 |
| 0 00 | 36 20 | 35 | 5 23 | 10 | 3 24 | 10 | 1 55 | 20 | 0 57 |
| 1 00 | 24 45 | 40 | 5 21 | 20 | 3 21 | 20 | 1 55. | 40 | 0 56 |
| 2 00 | 18 17 | 45 | 5 18 | 30 | 3 19 | 30 | 1 54 | 43 00 | 0 55 |
| 3 00 | 14 16 | 50 | 5 15 | 40 | 3 17 | 40 | 1 53 | 20 | 0 55 |
| 4 00 | 11 35 | 55 | 5 13 | 50 | 3 15 | 50 | 1 52 | 40 | 0 54 |
| 5 00 | 9 43 | 10 00 | 5 10 | 16 00 | 3 13 | 26 00 | 1 51 | 44 00 | 0 53 |
| 05 | 9 35 | 05 | 5 8 | 10 | 3 10 | 10 | 1 50 | 20 | 0 53 |
| 10 | 9 27 | 10 | 5 5 | 20 | 3 8 | 20 | 1 49 | 40 | 0 52 |
| 15 | 9 20 | 15 | 5 3 | 30 | 3 6 | 30 | 1 48 | 45 00 | 0 52 |
| 20 | 9 12 | 20 | 5 0 | 40 | 3 4 | 40 | 1 48 | 20 | 0 52 |
| 25 | 9 5 | 25 | 4 58 | 50 | 3 2 | 50 | 1 47 | 40 | 0 51 |
| 5 30 | 8 58 | 10 30 | 4 56 | 17 00 | 3 0 | 27 00 | 1 46 | 46 00 | 0 50 |
| 35 | 8 51 | 35 | 4 53 | 10 | 2 58 | 10 | 1 45 | 20 | 0 50 |
| 40 | 8 44 | 40 | 4 51 | 20 | 2 57 | 20 | 1 44 | 40 | 0 49 |
| 45 | 8 38 | 45 | 4 49 | 30 | 2 55 | 30 | 1 44 | 47 00 | 0 48 |
| 50 | 8 31 | 50 | 4 47 | 40 | 2 53 | 40 | 1 43 | 20 | 0 48 |
| 55 | 8 25 | 55 | 4 44 | 50 | 2 51 | 50 | 1 42 | 40 | 0 47 |
| 6 00 | 8 19 | 11 00 | 4 42 | 18 00 | 2 50 | 28 00 | 1 41 | 48 00 | 0 47 |
| 05 | 8 13 | 05 | 4 40 | 10 | 2 48 | 20 | 1 40 | 49 00 | 0 45 |
| 10 | 8 7• | 10 | 4 38 | 20 | 2 46 | 40 | 1 38 | 50 00 | 0 43 |
| 15 | 8 2 | 15 | 4 36 | 30 | 2 44 | 29 00 | 1 37 | 51 00 | 0 41 |
| 20 | 7 56 | 20 | 4 34 | 40 | 2 43 | 20 | 1 35 | 52 00 | 0 40 |
| 25 | 7 50 | 25 | 4 32 | 50 | 2 41 | 40 | 1 34 | 53 00 | 0 39 |
| 6 30 | 7 45 | 11 30 | 4 30 | 19 00 | 2 40 | 30 00 | 1 33 | 54 00 | 0 37 |
| 35 | 7 40 | 35 | 4 28 | 10 | 2 38 | 20 | 1 31 | 55 00 | 0 36 |
| 40 | 7 35 | 40 | 4 26 | 20 | 2 37 | 40 | 1 30 | 56 00 | 0 34 |
| 45 | 7 29 | 45 | 4 24 | 30 | 2 35 | 31 00 | 1 29 | 57 00 | 0 33 |
| 50 | 7 25 | 50 | 4 22 | 40 | 2 34 | 20 | 1 28 | 58 00 | 0 32 |
| 55 | 7 20 | 55 | 4 20 | 50 | 2 32 | 40 | 1 26 | 59 00 | 0 31 |
| 7 00 | 7 15 | 12 00 | 4 19 | 20 00 | 2 31 | 32 00 | 1 25 | 60 00 | 0 30 |
| 05 | 7 10 | 05 | 4 17 | 10 | 2 29 | 20 | 1 24 | 61 00 | 0 28 |
| 10 | 7 6 | 10 | 4 15 | 20 | 2 28 | 40 | 1 23 | 62 00 | 0 27 |
| 15 | 7 1 | 15 | 4 13 | 30 | 2 27 | 33 00 | 1 22 | 63 00 | 0 26 |
| 20 | 6 57 | 20 | 4 11 | 40 | 2 25 | 20 | 1 20 | 64 00 | 0 24 |
| 25 | 6 52 | 25 | 4 10 | 50 | 2 24 | 40 | 1 19 | 65 00 | 0 23 |
| 7 30 | 6 48 | 12 30 | 4 8 | 21 00 | 2 23 | 34 00 | 1 18 | 66 00 | 0 22 |
| 35 | 6 44 | 35 | 4 6 | 10 | 2 21 | 20 | 1 17 | 67 00 | 0 21 |
| 40 | 6 40 | 40 | 4 5 | 20 | 2 20 | 40 | 1 16 | 68 00 | 0 21 |
| 45 | 6 36 | 45 | 4 3 | 30 | 2 19 | 35 00 | 1 15 | 69 00 | 0 19 |
| 50 | 6 32 | 50 | 4 1 | 40 | 2 18 | 20 | 1 15 | 70 00 | 0 18 |
| 55 | 6 28 | 55 | 4 0 | 50 | 2 17 | 40 | 1 14 | 71 00 | 0 17 |
| 8 00 | 6 24 | 13 00 | 3 58 | 22 00 | 2 15 | 36 00 | 1 13 | 72 00 | 0 16 |
| 05 | 6 21 | 05 | 3 57 | 10 | 2 14 | 20 | 1 12 | 73 00 | 0 16 |
| 10 | 6 17 | 10 | 3 55 | 20 | 2 13 | 40 | 1 11 | 74 00 | 0 15 |
| 15 | 6 13 | 15 | 3 54 | 30 | 2 12 | 37 00 | 1 10 | 75 00 | 0 14 |
| 20 | 6 10 | 20 | 3 52 | 40 | 2 11 | 20 | 1 9 | 76 00 | 0 13 |
| 25 | 6 6 | 25 | 3 51 | 50 | 2 10 | 40 | 1 8 | 77 00 | 0 12 |
| 8 30 | 6 3 | 13 30 | 3 49 | 23 00 | 2 8 | 38 00 | 1 8 | 78 00 | 0 10 |
| 35 | 6 0 | 35 | 3 48 | 10 | 2 7 | 20 | 1 7 | 79 00 | 0 9 |
| 40 | 5 56 | 40 | 3 46 | 20 | 2 6 | 40 | 1 6 | 80 00 | 0 8 |
| 45 | 5 53 | 45 | 3 45 | 30 | 2 5 | 39 00 | 1 5 | 81 00 | 0 7 |
| 50 | 5 50 | 50 | 3 43 | 40 | 2 4 | 20 | 1 4 | 82 00 | 0 6 |
| 55 | 5 47 | 55 | 3 42 | 50 | 2 3 | 40 | 1 3 | 83 00 | 0 6 |
| 9 00 | 5 44 | 14 00 | 3 41 | 24 00 | 2 2 | 40 00 | 1 2 | 84 00 | 0 5 |
| 05 | 5 41 | 10 | 3 38 | 10 | 2 1 | 20 | 1 2 | 85 00 | 0 4 |
| 10 | 5 38 | 20 | 3 35 | 20 | 2 0 | 40 | 1 1 | 86 00 | 0 3 |
| 15 | 5 35 | 30 | 3 33 | 30 | 1 59 | 41 00 | 1 0 | 87 00 | 0 2 |
| 20 | 5 32 | 40 | 3 30 | 40 | 1 58 | 20 | 0 59 | 88 00 | 0 2 |
| 25 | 5 29 | 50 | 3 28 | 50 | 1 57 | 40 | 0 58 | 89 00 | 0 1 |
| 9 30 | 5 26 | 15 00 | 3 25 | 25 00 | 1 56 | 42 00 | 0 58 | 90 00 | 0 0 |

TABLE 21. [Page 527

## Correction of the Mean Refraction for the Height of the Barometer.

| Barom. Subtract | 0' 0" | 0' 30" | 1' 0" | 1' 30" | 2' 0" | 2' 30" | 3' 0" | 3' 30" | 4' 0" | 4' 30" | 5' 0" | 5' 30" | 6' 0" | 6' 30" | 7' 0" | 7' 30" | 8' 0" | 8' 30" | 9' 0" | 9' 30" | 10' 0" | Barom. Add |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27.50 | 0 | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 | 23 | 25 | 28 | 30 | 33 | 35 | 38 | 40 | 43 | 45 | 48 | 51 | |
| 27.55 | 0 | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 | 22 | 25 | 27 | 30 | 32 | 35 | 37 | 40 | 42 | 45 | 47 | 50 | |
| 27.60 | 0 | 2 | 5 | 7 | 10 | 12 | 14 | 17 | 19 | 22 | 24 | 27 | 29 | 31 | 34 | 36 | 39 | 41 | 44 | 46 | 49 | |
| 27.65 | 0 | 2 | 5 | 7 | 9 | 12 | 14 | 16 | 19 | 21 | 24 | 26 | 28 | 31 | 33 | 36 | 38 | 40 | 43 | 45 | 48 | |
| 27.70 | 0 | 2 | 5 | 7 | 9 | 11 | 14 | 16 | 18 | 21 | 23 | 25 | 28 | 30 | 32 | 35 | 37 | 39 | 42 | 44 | 47 | |
| 27.75 | 0 | 2 | 4 | 7 | 9 | 11 | 13 | 16 | 18 | 20 | 23 | 25 | 27 | 29 | 32 | 34 | 36 | 39 | 41 | 43 | 46 | |
| 27.80 | 0 | 2 | 4 | 7 | 9 | 11 | 13 | 15 | 18 | 20 | 22 | 24 | 27 | 29 | 31 | 33 | 35 | 38 | 40 | 42 | 45 | |
| 27.85 | 0 | 2 | 4 | 6 | 9 | 11 | 13 | 15 | 17 | 19 | 22 | 24 | 26 | 28 | 30 | 32 | 35 | 37 | 39 | 41 | 44 | |
| 27.90 | 0 | 2 | 4 | 6 | 8 | 10 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 30 | 32 | 34 | 36 | 38 | 40 | 43 | |
| 27.95 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 42 | |
| 28.00 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 41 | |
| 28.05 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | |
| 28.10 | 0 | 2 | 4 | 6 | 8 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 34 | 36 | 38 | |
| 28.15 | 0 | 2 | 4 | 6 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 37 | |
| 28.20 | 0 | 2 | 4 | 5 | 7 | 9 | 11 | 13 | 14 | 16 | 18 | 20 | 22 | 24 | 25 | 27 | 29 | 31 | 33 | 35 | 36 | |
| 28.25 | 0 | 2 | 3 | 5 | 7 | 9 | 10 | 12 | 14 | 16 | 18 | 19 | 21 | 23 | 25 | 26 | 28 | 30 | 32 | 34 | 35 | |
| 28.30 | 0 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 14 | 15 | 17 | 19 | 21 | 22 | 24 | 26 | 27 | 29 | 31 | 33 | 34 | |
| 28.35 | 0 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 | 17 | 18 | 20 | 22 | 23 | 25 | 27 | 28 | 30 | 32 | 33 | |
| 28.40 | 0 | 2 | 3 | 5 | 6 | 8 | 10 | 11 | 13 | 14 | 16 | 18 | 19 | 21 | 23 | 24 | 26 | 27 | 29 | 31 | 32 | |
| 28.45 | 0 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 14 | 16 | 17 | 19 | 20 | 22 | 23 | 25 | 27 | 28 | 30 | 31 | |
| 28.50 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 14 | 15 | 17 | 18 | 20 | 21 | 23 | 24 | 26 | 27 | 29 | 30 | 31.50 |
| 28.55 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 | 15 | 16 | 17 | 19 | 20 | 22 | 23 | 25 | 26 | 28 | 29 | 31.45 |
| 28.60 | 0 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 13 | 14 | 15 | 17 | 18 | 20 | 21 | 23 | 24 | 25 | 27 | 28 | 31.40 |
| 28.65 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 11 | 12 | 14 | 15 | 16 | 18 | 19 | 20 | 22 | 23 | 25 | 26 | 27 | 31.35 |
| 28.70 | 0 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 12 | 13 | 14 | 16 | 17 | 18 | 20 | 21 | 22 | 24 | 25 | 26 | 31.30 |
| 28.75 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 9 | 10 | 11 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | 21 | 23 | 24 | 25 | 31.25 |
| 28.80 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 31.20 |
| 28.85 | 0 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 15 | 16 | 17 | 19 | 20 | 21 | 22 | 23 | 31.15 |
| 28.90 | 0 | 1 | 2 | 3 | 4 | 5 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 18 | 19 | 20 | 21 | 31.10 |
| 28.95 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 31.05 |
| 29.00 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 31.00 |
| 29.05 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 30.95 |
| 29.10 | 0 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 15 | 16 | 17 | 18 | 30.90 |
| 29.15 | 0 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 15 | 16 | 17 | 30.85 |
| 29.20 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 15 | 16 | 30.80 |
| 29.25 | 0 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 14 | 15 | 30.75 |
| 29.30 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 13 | 14 | 30.70 |
| 29.35 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 11 | 12 | 13 | 13 | 30.65 |
| 29.40 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 8 | 9 | 10 | 10 | 11 | 12 | 12 | 30.60 |
| 29.45 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 11 | 30.55 |
| 29.50 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 30.50 |
| 29.55 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 30.45 |
| 29.60 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 30.40 |
| 29.65 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 30.35 |
| 29.70 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 6 | 30.30 |
| 29.75 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 30.25 |
| 29.80 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2. | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 30.20 |
| 29.85 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 30.15 |
| 29.90 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 30.10 |
| 29.95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 30.05 |
| 30.00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30.00 |

Subtract. 0″ 30″ — 0′ 1′ 2′ 3′ 4′ 5′ 6′ 7′ 8′ 9′ 10′ — Add. Barom.

Mean refraction.

# TABLE 22.

### Correction of the Mean Refraction for the Height of the Thermometer.

Mean refraction.

| Ther. Add. | 0' | | 1' | | 2' | | 3' | | 4' | | 5' | | 6' | | 7' | | 8' | | 9' | | 10' | Ther. Add. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0′ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | ° |
| −10 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 33 | 37 | 41 | 46 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | −10 |
| − 8 | 0 | 4 | 8 | 12 | 15 | 19 | 23 | 27 | 31 | 36 | 40 | 44 | 48 | 53 | 58 | 62 | 67 | 72 | 77 | 82 | 87 | − 8 |
| − 6 | 0 | 4 | 7 | 11 | 15 | 19 | 22 | 26 | 30 | 34 | 38 | 42 | 47 | 51 | 55 | 60 | 64 | 69 | 74 | 79 | 84 | − 6 |
| − 4 | 0 | 4 | 7 | 11 | 14 | 18 | 22 | 25 | 29 | 33 | 37 | 41 | 45 | 49 | 53 | 57 | 62 | 66 | 71 | 76 | 80 | − 4 |
| − 2 | 0 | 3 | 7 | 10 | 14 | 17 | 21 | 24 | 28 | 31 | 35 | 39 | 43 | 47 | 51 | 55 | 59 | 64 | 68 | 72 | 77 | − 2 |
| 0 | 0 | 3 | 7 | 10 | 13 | 16 | 20 | 23 | 27 | 30 | 34 | 37 | 41 | 45 | 49 | 53 | 57 | 61 | 65 | 69 | 74 | 0 |
| 2 | 0 | 3 | 6 | 9 | 12 | 16 | 19 | 22 | 25 | 29 | 32 | 36 | 39 | 43 | 47 | 50 | 54 | 58 | 62 | 66 | 70 | 2 |
| 4 | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 28 | 31 | 34 | 37 | 41 | 44 | 48 | 52 | 55 | 59 | 63 | 67 | 4 |
| 6 | 0 | 3 | 6 | 8 | 11 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 36 | 39 | 42 | 46 | 49 | 53 | 56 | 60 | 64 | 6 |
| 8 | 0 | 3 | 5 | 8 | 11 | 14 | 16 | 19 | 22 | 25 | 28 | 31 | 34 | 37 | 40 | 43 | 47 | 50 | 54 | 57 | 61 | 8 |
| 10 | 0 | 3 | 5 | 8 | 10 | 13 | 15 | 18 | 21 | 24 | 26 | 29 | 32 | 35 | 38 | 41 | 44 | 48 | 51 | 54 | 58 | 10 |
| 11 | 0 | 2 | 5 | 7 | 10 | 13 | 15 | 18 | 20 | 23 | 26 | 28 | 31 | 34 | 37 | 40 | 43 | 46 | 49 | 53 | 56 | 11 |
| 12 | 0 | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 | 22 | 25 | 28 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 12 |
| 13 | 0 | 2 | 5 | 7 | 9 | 12 | 14 | 17 | 19 | 22 | 24 | 27 | 30 | 32 | 35 | 38 | 41 | 44 | 47 | 50 | 53 | 13 |
| 14 | 0 | 2 | 5 | 7 | 9 | 11 | 14 | 16 | 19 | 21 | 24 | 26 | 29 | 31 | 34 | 37 | 40 | 42 | 45 | 48 | 51 | 14 |
| 15 | 0 | 2 | 4 | 7 | 9 | 11 | 13 | 16 | 18 | 20 | 23 | 25 | 28 | 30 | 33 | 36 | 38 | 41 | 44 | 47 | 50 | 15 |
| 16 | 0 | 2 | 4 | 6 | 9 | 11 | 13 | 15 | 18 | 20 | 22 | 25 | 27 | 29 | 32 | 35 | 37 | 40 | 43 | 45 | 48 | 16 |
| 17 | 0 | 2 | 4 | 6 | 8 | 10 | 13 | 15 | 17 | 19 | 21 | 24 | 26 | 29 | 31 | 33 | 36 | 39 | 41 | 44 | 47 | 17 |
| 18 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 19 | 21 | 23 | 25 | 28 | 30 | 32 | 35 | 37 | 40 | 43 | 45 | 18 |
| 19 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 27 | 29 | 31 | 34 | 36 | 39 | 41 | 44 | 19 |
| 20 | 0 | 2 | 4 | 6 | 8 | 9 | 11 | 13 | 15 | 17 | 19 | 22 | 24 | 26 | 28 | 30 | 33 | 35 | 37 | 40 | 42 | 20 |
| 21 | 0 | 2 | 4 | 5 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 34 | 36 | 38 | 41 | 21 |
| 22 | 0 | 2 | 3 | 5 | 7 | 9 | 11 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 35 | 37 | 39 | 22 |
| 23 | 0 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 14 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 36 | 38 | 23 |
| 24 | 0 | 2 | 3 | 5 | 6 | 8 | 10 | 11 | 13 | 15 | 17 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 24 |
| 25 | 0 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 13 | 14 | 16 | 18 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 25 |
| 26 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 11 | 12 | 14 | 15 | 17 | 19 | 20 | 22 | 24 | 26 | 28 | 29 | 31 | 33 | 26 |
| 27 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 | 15 | 16 | 18 | 19 | 21 | 23 | 25 | 26 | 28 | 30 | 32 | 27 |
| 28 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 10 | 11 | 12 | 14 | 15 | 17 | 19 | 20 | 22 | 23 | 25 | 27 | 29 | 30 | 28 |
| 29 | 0 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 11 | 12 | 13 | 15 | 16 | 18 | 19 | 21 | 22 | 24 | 26 | 27 | 29 | 29 |
| 30 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 9 | 10 | 11 | 13 | 14 | 15 | 17 | 18 | 20 | 21 | 23 | 24 | 26 | 28 | 30 |
| 31 | 0 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 11 | 12 | 13 | 15 | 16 | 17 | 19 | 20 | 22 | 23 | 25 | 26 | 31 |
| 32 | 0 | 1 | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | 22 | 23 | 25 | 32 |
| 33 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 | 14 | 15 | 17 | 18 | 19 | 21 | 22 | 23 | 33 |
| 34 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 18 | 19 | 21 | 22 | 34 |
| 35 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 35 |
| 36 | 0 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 36 |
| 37 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 37 |
| 38 | 0 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 13 | 14 | 15 | 16 | 38 |
| 39 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 39 |
| 40 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 10 | 11 | 12 | 13 | 13 | 40 |
| 41 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 11 | 12 | 41 |
| 42 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 42 |
| 43 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 43 |
| 44 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 44 |
| 45 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 45 |
| 46 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 46 |
| 47 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 47 |
| 48 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 48 |
| 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 49 |
| 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 |

| Add. | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | 30″ | 0″ | Add. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ther. | 0′ | | 1′ | | 2′ | | 3′ | | 4′ | | 5′ | | 6′ | | 7′ | | 8′ | | 9′ | | 10′ | Ther. |

Mean refraction.

TABLE 22. [Page 529

Correction of the Mean Refraction for the Height of the Thermometer.

| Ther. Subt. | 0' | | 1' | | 2' | | 3' | | 4' | | 5' | | 6' | | 7' | | 8' | | 9' | | 10' | Ther. Subt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | |
| ° | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " | " | ° |
| 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 |
| 51 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 51 |
| 52 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 52 |
| 53 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 53 |
| 54 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2. | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 54 |
| 55 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 55 |
| 56 | 0. | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 56 |
| 57 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 57 |
| 58 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 10 | 58 |
| 59 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 10 | 10 | 11 | 12 | 59 |
| 60 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 11 | 12 | 13 | 60 |
| 61 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 12 | 13 | 14 | 61 |
| 62 | 0 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 15 | 62 |
| 63 | 0 | 1 | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 63 |
| 64 | 0 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 64 |
| 65 | 0 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 65 |
| 66 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 66 |
| 67 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 18 | 19 | 20 | 22 | 67 |
| 68 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 11 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | 22 | 23 | 68 |
| 69 | 0 | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 17 | 19 | 20 | 21 | 23 | 24 | 69 |
| 70 | 0 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 12 | 14 | 16 | 17 | 18 | 20 | 21 | 22 | 24 | 25 | 70 |
| 71 | 0 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 12 | 13 | 15 | 16 | 18 | 19 | 20 | 22 | 23 | 25 | 27 | 71 |
| 72 | 0 | 1 | 2 | 4 | 5 | 6 | 8 | 9 | 10 | 11 | 13 | 14 | 16 | 17 | 18 | 20 | 21 | 23 | 25 | 26 | 28 | 72 |
| 73 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 11 | 12 | 13 | 14 | 16 | 18 | 19 | 21 | 22 | 24 | 26 | 27 | 29 | 73 |
| 74 | 0 | 1 | 3 | 4 | 5 | 7 | 8 | 10 | 11 | 12 | 14 | 15 | 17 | 18 | 20 | 22 | 23 | 25 | 27 | 28 | 30 | 74 |
| 75 | 0 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 13 | 14 | 16 | 18 | 19 | 21 | 22 | 24 | 26 | 28 | 29 | 31 | 75 |
| 76 | 0 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 | 15 | 16 | 18 | 20 | 22 | 23 | 25 | 27 | 29 | 31 | 32 | 76 |
| 77 | 0 | 1 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 14 | 16 | 17 | 19 | 21 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 77 |
| 78 | 0 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 13 | 14 | 16 | 18 | 20 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 78 |
| 79 | 0 | 2 | 3 | 5 | 6 | 8 | 10 | 11 | 13 | 15 | 17 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 79 |
| 80 | 0 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 14 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 80 |
| 81 | 0 | 2 | 3 | 5 | 7 | 9 | 10 | 12 | 14 | 16 | 18 | 20 | 21 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 81 |
| 82 | 0 | 2 | 4 | 5 | 7 | 9 | 11 | 13 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 31 | 33 | 35 | 37 | 40 | 82 |
| 83 | 0 | 2 | 4 | 5 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 34 | 36 | 38 | 41 | 83 |
| 84 | 0 | 2 | 4 | 6 | 8 | 9 | 11 | 13 | 15 | .17 | 19 | 21 | 23 | 26 | 28 | 30 | 32 | 35 | 37 | 39 | 42 | 84 |
| 85 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 29 | 31 | 33 | 36 | 38 | 40 | 43 | 85 |
| 86 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 23 | 25 | 27 | 29 | 32 | 34 | 37 | 39 | 42 | 44 | 86 |
| 87 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 17 | 19 | 21 | 23 | 25 | 28 | 30 | 32 | 35 | 38 | 40 | 43 | 45 | 87 |
| 88 | 0 | 2 | 4 | 6 | 8 | 10 | 13 | 15 | 17 | 19 | 21 | 24 | 26 | 28 | 31 | 33 | 36 | 38 | 41 | 44 | 46 | 88 |
| 89 | 0 | 2 | 4 | 6 | 9 | 11 | 13 | 15 | 17 | 20 | 22 | 24 | 27 | 29 | 32 | 34 | 37 | 39 | 42 | 45 | 48 | 89 |
| 90 | 0 | 2 | 4 | 7 | 9 | 11 | 13 | 16 | 18 | 20 | 23 | 25 | 27 | 30 | 32 | 35 | 38 | 40 | 43 | 46 | 49 | 90 |
| 91 | 0 | 2 | 4 | 7 | 9 | 11 | 14 | 16 | 18 | 21 | 23 | 25 | 28 | 31 | 33 | 36 | 39 | 41 | 44 | 47 | 50 | 91 |
| 92 | 0 | 2 | 5 | 7 | 9 | 11 | 14 | 16 | 19 | 21 | 24 | 26 | 29 | 31 | 34 | 37 | 39 | 42 | 45 | 48 | 51 | 92 |
| 93 | 0 | 2 | 5 | 7 | 9 | 12 | 14 | 17. | 19 | 22 | 24 | 27 | 29 | 32 | 35 | 37 | 40 | 43 | 46 | 49 | 52 | 93 |
| 94 | 0 | 2 | 5 | 7 | 10 | 12 | 14 | 17 | 19 | 22 | 25 | 27 | 30 | 33 | 35 | 38 | 41 | 44 | 47 | 50 | 53 | 94 |
| 95 | 0 | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 | 22 | 25 | 28 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 | 54 | 95 |
| 96 | 0 | 2 | 5 | 7 | 10 | 12 | 15 | 18 | 20 | 23 | 26 | 28 | 31 | 34 | 37 | 40 | 43 | 46 | 49 | 52 | 55 | 96 |
| 97 | 0 | 3 | 5 | 8 | 10 | 13 | 15 | 18 | 21 | 23 | 26 | 29 | 32 | 35 | 38 | 41 | 44 | 47 | 50 | 53 | 56 | 97 |
| 98 | 0 | 3 | 5 | 8 | 10 | 13 | 16 | 18 | 21 | 24 | 27 | 29 | 32 | 35 | 38 | 41 | 44 | 48 | 51 | 54 | 58 | 98 |
| 99 | 0 | 3 | 5 | 8 | 11 | 13 | 16 | 19 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 49 | 52 | 55 | 59 | 99 |
| 100 | 0 | 3 | 5 | 8 | 11 | 13 | 16 | 19 | 22 | 25 | 28 | 31 | 34 | 37 | 40 | 43 | 46 | 50 | 53 | 56 | 60 | 100 |
| Subt. | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | 30" | 0" | Subt. |
| | 0' | | 1' | | 2' | | 3' | | 4' | | 5' | | 6' | | 7' | | 8' | | 9' | | 10' | |
| Ther. | | | | | | | | | | | | | | | | | | | | | | Ther. |

Mean refraction.

## TABLE 23.

Correction of the Moon's Altitude for parallax and refraction corresponding to a mean value of the horizontal parallax, 57′ 30″.

| Moon's alt. | Corr. | Moon's alt. | Corr. | Moon's alt. | Corr. | Moon's alt. | Corr. |
|---|---|---|---|---|---|---|---|
| ° | ′ | ° | ′ | ° | ′ | ° | ′ |
| 10 | 51 | 31 | 48 | 51 | 35 | 71 | 18 |
| 11 | 52 | 32 | 47 | 52 | 35 | 72 | 17 |
| 12 | 52 | 33 | 47 | 53 | 34 | 73 | 17 |
| 13 | 52 | 34 | 46 | 54 | 33 | 74 | 16 |
| 14 | 52 | 35 | 46 | 55 | 32 | 75 | 15 |
| 15 | 52 | 36 | 45 | 56 | 32 | 76 | 14 |
| 16 | 52 | 37 | 45 | 57 | 31 | 77 | 13 |
| 17 | 52 | 38 | 44 | 58 | 30 | 78 | 12 |
| 18 | 52 | 39 | 44 | 59 | 29 | 79 | 11 |
| 19 | 52 | 40 | 43 | 60 | 28 | 80 | 10 |
| 20 | 51 |  |  |  |  |  |  |
| 21 | 51 | 41 | 42 | 61 | 27 | 81 | 9 |
| 22 | 51 | 42 | 42 | 62 | 26 | 82 | 8 |
| 23 | 51 | 43 | 41 | 63 | 26 | 83 | 7 |
| 24 | 50 | 44 | 40 | 64 | 25 | 84 | 6 |
| 25 | 50 | 45 | 40 | 65 | 24 | 85 | 5 |
| 26 | 50 | 46 | 39 | 66 | 23 | 86 | 4 |
| 27 | 49 | 47 | 38 | 67 | 22 | 87 | 3 |
| 28 | 49 | 48 | 38 | 68 | 21 | 88 | 2 |
| 29 | 49 | 49 | 37 | 69 | 20 | 89 | 1 |
| 30 | 48 | 50 | 36 | 70 | 19 | 90 | 0 |

## TABLE 24.

Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer, 30 inches.—Fahrenheit's Thermometer, 50°.]

| Moon's app. alt. | Horizontal parallax. | | | | | | | | Seconds of parallax. | Correction for seconds of parallax.—Add. | | | | | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ |  | 0″ | 2″ | 4″ | 6″ | 8″ |  |
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ |  |
| 5 0 | 43 56 | 44 56 | 45 56 | 46 56 | 47 56 | 48 55 | 49 55 | 50 55 | 0 | 0 | 2 | 4 | 6 | 8 |  |
| 10 | 44 11 | 45 11 | 46 11 | 47 11 | 48 11 | 49 10 | 50 10 | 51 10 | 10 | 10 | 12 | 14 | 16 | 18 |  |
| 20 | 25 | 25 | 25 | 25 | 25 | 24 | 24 | 24 | 20 | 20 | 22 | 24 | 26 | 28 |  |
| 30 | 39 | 39 | 38 | 38 | 38 | 38 | 37 | 37 | 30 | 30 | 32 | 34 | 36 | 38 |  |
| 40 | 52 | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 40 | 40 | 42 | 44 | 46 | 48 |  |
| 50 | 45 4 | 46 3 | 47 3 | 48 3 | 49 3 | 50 3 | 51 3 | 52 3 | 50 | 50 | 52 | 54 | 56 | 58 |  |
| 6 0 | 45 15 | 46 15 | 47 14 | 48 14 | 49 14 | 50 13 | 51 13 | 52 13 | 0 | 0 | 2 | 4 | 6 | 8 |  |
| 10 | 26 | 26 | 25 | 25 | 25 | 25 | 25 | 25 | 10 | 10 | 12 | 14 | 16 | 18 |  |
| 20 | 36 | 36 | 36 | 35 | 35 | 34 | 34 | 34 | 20 | 20 | 22 | 24 | 26 | 28 |  |
| 30 | 46 | 46 | 45 | 45 | 45 | 44 | 44 | 44 | 30 | 30 | 32 | 34 | 36 | 38 |  |
| 40 | 55 | 55 | 55 | 54 | 54 | 54 | 53 | 53 | 40 | 40 | 42 | 44 | 46 | 48 |  |
| 50 | 46 4 | 47 3 | 48 3 | 49 3 | 50 3 | 51 2 | 52 1 | 53 1 | 50 | 50 | 52 | 54 | 56 | 58 |  |
| 7 0 | 46 12 | 47 12 | 48 12 | 49 12 | 50 12 | 51 11 | 52 11 | 53 10 | 0 | 0 | 2 | 4 | 6 | 8 |  |
| 10 | 21 | 20 | 20 | 20 | 19 | 18 | 18 | 18 | 10 | 10 | 12 | 14 | 16 | 18 |  |
| 20 | 29 | 28 | 28 | 27 | 27 | 26 | 25 | 25 | 20 | 20 | 22 | 24 | 26 | 28 |  |
| 30 | 36 | 36 | 35 | 35 | 34 | 34 | 34 | 33 | 30 | 30 | 32 | 34 | 36 | 38 |  |
| 40 | 43 | 42 | 42 | 41 | 41 | 40 | 40 | 40 | 40 | 40 | 42 | 44 | 46 | 48 |  |
| 50 | 50 | 49 | 48 | 48 | 48 | 47 | 46 | 46 | 50 | 50 | 52 | 54 | 56 | 58 | Add. |
| 8 0 | 46 56 | 47 56 | 48 55 | 49 54 | 50 54 | 51 54 | 52 53 | 53 53 | 0 | 0 | 2 | 4 | 6 | 8 | 1′ 1″ |
| 10 | 47 2 | 48 2 | 49 1 | 50 0 | 51 0 | 59 | 59 | 58 | 10 | 10 | 12 | 14 | 16 | 18 | 2 1 |
| 20 | 8 | 7 | 7 | 6 | 6 | 52 5 | 53 4 | 54 4 | 20 | 20 | 22 | 24 | 26 | 28 | 3 2 |
| 30 | 13 | 13 | 12 | 11 | 11 | 10 | 10 | 9 | 30 | 30 | 32 | 34 | 36 | 38 | 4 2 |
| 40 | 19 | 18 | 17 | 17 | 16 | 16 | 15 | 14 | 40 | 40 | 42 | 44 | 46 | 48 | 5 3 |
| 50 | 24 | 23 | 22 | 22 | 21 | 20 | 19 | 19 | 50 | 50 | 52 | 54 | 56 | 58 | 6 4 |
| 9 0 | 47 28 | 48 27 | 49 26 | 50 26 | 51 25 | 52 24 | 53 24 | 54 23 | 0 | 0 | 2 | 4 | 6 | 8 | 7 4 |
| 10 | 33 | 32 | 31 | 30 | 30 | 29 | 28 | 27 | 10 | 10 | 12 | 14 | 16 | 18 | 8 5 |
| 20 | 37 | 36 | 35 | 34 | 34 | 33 | 32 | 32 | 20 | 20 | 22 | 24 | 26 | 28 | 9 5 |
| 30 | 41 | 41 | 40 | 39 | 38 | 37 | 37 | 36 | 30 | 30 | 32 | 34 | 36 | 38 |  |
| 40 | 45 | 44 | 43 | 43 | 42 | 41 | 40 | 39 | 40 | 40 | 42 | 44 | 46 | 48 |  |
| 50 | 49 | 48 | 47 | 46 | 46 | 45 | 44 | 44 | 50 | 49 | 51 | 53 | 55 | 57 |  |

TABLE 24. [Page 531

## Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

| Moon's app. alt. | Horizontal parallax 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | Seconds of parallax | Correction for seconds of parallax.—Add. 0" | 2" | 4" | 6" | 8" | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10 0** | 47 53 | 48 52 | 49 51 | 50 50 | 51 50 | 52 48 | 53 48 | 54 47 | 0 | 0 | 2 | 4 | 6 | 8 | **Add.** 1' 0" |
| 10 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 50 | 10 | 10 | 12 | 14 | 16 | 18 | 2 1 |
| 20 | 59 | 58 | 57 | 56 | 55 | 55 | 54 | 53 | 20 | 20 | 22 | 24 | 26 | 28 | 3 1 |
| 30 | 48 2 | 49 1 | 50 0 | 59 | 58 | 57 | 56 | 55 | 30 | 29 | 31 | 33 | 35 | 37 | 4 1 |
| 40 | 5 | 4 | 2 | 51 2 | 52 1 | 53 0 | 59 | 58 | 40 | 39 | 41 | 43 | 45 | 47 | 5 2 |
| 50 | 7 | 6 | 5 | 4 | 4 | 2 | 54 1 | 55 0 | 50 | 49 | 51 | 53 | 55 | 57 | 6 2 |
| **11 0** | 48 10 | 49 9 | 50 8 | 51 7 | 52 7 | 53 5 | 54 4 | 55 3 | 0 | 0 | 2 | 4 | 6 | 8 | 7 2 |
| 10 | 12 | 11 | 10 | 9 | 9 | 7 | 6 | 5 | 10 | 10 | 12 | 14 | 16 | 18 | 8 2 |
| 20 | 15 | 14 | 12 | 12 | 11 | 9 | 8 | 7 | 20 | 20 | 22 | 24 | 26 | 28 | 9 3 |
| 30 | 17 | 16 | 14 | 13 | 13 | 11 | 10 | 9 | 30 | 29 | 31 | 33 | 35 | 37 | |
| 40 | 19 | 18 | 17 | 15 | 15 | 13 | 12 | 11 | 40 | 39 | 41 | 43 | 45 | 47 | |
| 50 | 21 | 20 | 18 | 17 | 17 | 15 | 14 | 13 | 50 | 49 | 51 | 53 | 55 | 57 | |
| **12 0** | 48 22 | 49 21 | 50 19 | 51 18 | 52 17 | 53 17 | 54 15 | 55 14 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 24 | 23 | 21 | 20 | 19 | 18 | 16 | 15 | 10 | 10 | 12 | 14 | 16 | 18 | — |
| 20 | 26 | 25 | 23 | 22 | 21 | 20 | 18 | 17 | 20 | 20 | 22 | 24 | 25 | 27 | |
| 30 | 27 | 26 | 24 | 23 | 22 | 20 | 19 | 18 | 30 | 29 | 31 | 33 | 35 | 37 | |
| 40 | 28 | 27 | 25 | 24 | 23 | 21 | 20 | 19 | 40 | 39 | 41 | 43 | 45 | 47 | |
| 50 | 29 | 28 | 26 | 25 | 24 | 22 | 21 | 20 | 50 | 49 | 51 | 53 | 55 | 57 | |
| **13 0** | 48 30 | 49 29 | 50 27 | 51 26 | 52 25 | 53 23 | 54 22 | 55 20 | 0 | 0 | 2 | 4 | 6 | 8 | 1 0 |
| 10 | 31 | 30 | 28 | 27 | 26 | 24 | 22 | 21 | 10 | 10 | 12 | 14 | 16 | 18 | 2 0 |
| 20 | 32 | 31 | 29 | 27 | 26 | 24 | 23 | 21 | 20 | 19 | 21 | 23 | 25 | 27 | 3 0 |
| 30 | 33 | 32 | 30 | 28 | 27 | 25 | 23 | 22 | 30 | 29 | 31 | 33 | 35 | 37 | 4 0 |
| 40 | 34 | 32 | 30 | 29 | 28 | 26 | 24 | 22 | 40 | 39 | 41 | 43 | 45 | 47 | 5 0 |
| 50 | 35 | 33 | 31 | 30 | 28 | 26 | 25 | 23 | 50 | 49 | 51 | 53 | 55 | 57 | 6 0 |
| **14 0** | 48 35 | 49 33 | 50 31 | 51 30 | 52 28 | 53 26 | 54 25 | 55 23 | 0 | 0 | 2 | 4 | 6 | 8 | 7 0 |
| 10 | 35 | 34 | 32 | 30 | 28 | 26 | 25 | 23 | 10 | 10 | 12 | 14 | 16 | 18 | 8 0 |
| 20 | 36 | 34 | 32 | 30 | 29 | 27 | 25 | 24 | 20 | 19 | 21 | 23 | 25 | 27 | 9 0 |
| 30 | 36 | 34 | 32 | 30 | 29 | 27 | 25 | 23 | 30 | 29 | 31 | 33 | 35 | 37 | |
| 40 | 36 | 34 | 32 | 30 | 29 | 27 | 25 | 23 | 40 | 39 | 41 | 43 | 45 | 47 | |
| 50 | 36 | 34 | 32 | 30 | 29 | 27 | 25 | 23 | 50 | 49 | 51 | 53 | 55 | 57 | |
| **15 0** | 48 36 | 49 35 | 50 33 | 51 31 | 52 29 | 53 27 | 54 25 | 55 23 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 36 | 35 | 32 | 30 | 28 | 26 | 24 | 22 | 10 | 10 | 12 | 14 | 16 | 18 | |
| 20 | 36 | 35 | 32 | 30 | 28 | 26 | 24 | 22 | 20 | 19 | 21 | 23 | 25 | 27 | |
| 30 | 36 | 34 | 31 | 29 | 28 | 25 | 23 | 21 | 30 | 29 | 31 | 33 | 35 | 37 | |
| 40 | 36 | 34 | 31 | 29 | 27 | 25 | 23 | 21 | 40 | 39 | 41 | 43 | 45 | 47 | |
| 50 | 35 | 33 | 30 | 28 | 26 | 24 | 21 | 19 | 50 | 49 | 51 | 53 | 55 | 57 | |
| **16 0** | 48 35 | 49 32 | 50 29 | 51 27 | 52 25 | 53 23 | 54 20 | 55 18 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 34 | 32 | 29 | 27 | 25 | 23 | 20 | 18 | 10 | 10 | 12 | 13 | 15 | 17 | |
| 20 | 34 | 32 | 29 | 27 | 25 | 22 | 20 | 17 | 20 | 19 | 21 | 23 | 25 | 27 | |
| 30 | 33 | 31 | 28 | 26 | 24 | 21 | 19 | 16 | 30 | 29 | 31 | 33 | 35 | 36 | |
| 40 | 33 | 31 | 28 | 25 | 23 | 21 | 18 | 16 | 40 | 38 | 40 | 42 | 44 | 46 | **Sub.** |
| 50 | 32 | 30 | 27 | 24 | 22 | 20 | 17 | 15 | 50 | 48 | 50 | 52 | 54 | 56 | |
| **17 0** | 48 31 | 49 29 | 50 26 | 51 23 | 52 21 | 53 18 | 54 16 | 55 13 | 0 | 0 | 2 | 4 | 6 | 8 | 1' 0" |
| 10 | 30 | 28 | 25 | 22 | 20 | 17 | 14 | 12 | 10 | 10 | 12 | 13 | 15 | 17 | 2 0 |
| 20 | 28 | 26 | 23 | 20 | 18 | 15 | 12 | 10 | 20 | 19 | 21 | 23 | 25 | 27 | 3 0 |
| 30 | 27 | 25 | 22 | 19 | 17 | 14 | 11 | 9 | 30 | 29 | 31 | 33 | 34 | 36 | 4 0 |
| 40 | 26 | 24 | 21 | 18 | 16 | 13 | 10 | 7 | 40 | 38 | 40 | 42 | 44 | 46 | 5 1 |
| 50 | 26 | 23 | 20 | 17 | 15 | 12 | 9 | 6 | 50 | 48 | 50 | 52 | 53 | 55 | 6 1 |
| **18 0** | 48 24 | 49 21 | 50 18 | 51 15 | 52 13 | 53 10 | 54 7 | 55 4 | 0 | 0 | 2 | 4 | 6 | 8 | 7 1 |
| 10 | 23 | 20 | 17 | 14 | 12 | 9 | 6 | 3 | 10 | 10 | 11 | 13 | 15 | 17 | 8 1 |
| 20 | 22 | 19 | 16 | 13 | 11 | 8 | 5 | 2 | 20 | 19 | 21 | 23 | 25 | 27 | 9 1 |
| 30 | 21 | 18 | 15 | 12 | 10 | 6 | 3 | 0 | 30 | 29 | 30 | 32 | 34 | 36 | |
| 40 | 20 | 17 | 14 | 10 | 8 | 4 | 1 | 54 58 | 40 | 38 | 40 | 42 | 44 | 46 | |
| 50 | 18 | 15 | 12 | 9 | 6 | 2 | 53 59 | 56 | 50 | 48 | 50 | 51 | 53 | 55 | |
| **19 0** | 48 16 | 49 13 | 50 10 | 51 7 | 52 4 | 53 0 | 53 57 | 54 55 | 0 | 0 | 2 | 4 | 6 | 8 | |
| 10 | 15 | 12 | 8 | 5 | 2 | 52 59 | 55 | 53 | 10 | 10 | 11 | 13 | 15 | 17 | |
| 20 | 13 | 10 | 6 | 3 | 0 | 57 | 53 | 51 | 20 | 19 | 21 | 23 | 25 | 27 | |
| 30 | 12 | 8 | 5 | 2 | 51 58 | 55 | 51 | 49 | 30 | 29 | 30 | 32 | 34 | 36 | |
| 40 | 10 | 6 | 3 | 0 | 56 | 53 | 49 | 47 | 40 | 38 | 40 | 42 | 44 | 46 | |
| 50 | 9 | 5 | 2 | 50 58 | 55 | 51 | 48 | 45 | 50 | 48 | 50 | 51 | 53 | 55 | |

# TABLE 24.

## Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

| Moon's app. alt. | Horizontal parallax. 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | Seconds of parallax | Correction for seconds of parallax.—Add. 0" | 2" | 4" | 6" | 8" | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ' | ' " | ' " | ' " | ' " | ' " | ' " | ' " | ' " | " | " | " | " | " | " | Sub. |
| 20 0 | 48 6 | 49 3 | 49 59 | 50 56 | 51 52 | 52 49 | 53 45 | 54 42 | 0 | 0 | 2 | 4 | 6 | 8 | 1' 0" |
| 10 | 5 | 2 | 58 | 55 | 51 | 47 | 43 | 40 | 10 | 9 | 11 | 13 | 15 | 17 | 2 0 |
| 20 | 3 | 0 | 56 | 52 | 49 | 45 | 41 | 37 | 20 | 19 | 21 | 23 | 24 | 26 | 3 1 |
| 30 | 1 | 48 58 | 53 | 50 | 46 | 42 | 38 | 35 | 30 | 28 | 30 | 32 | 34 | 36 | 4 1 |
| 40 | 59 | 56 | 52 | 48 | 44 | 40 | 36 | 33 | 40 | 38 | 39 | 41 | 43 | 45 | 5 1 |
| 50 | 57 | 54 | 50 | 46 | 42 | 38 | 34 | 30 | 50 | 47 | 49 | 51 | 53 | 54 | 6 1 |
| 21 0 | 47 55 | 48 51 | 49 47 | 50 43 | 51 39 | 52 35 | 53 31 | 54 28 | 0 | 0 | 2 | 4 | 6 | 7 | 7 1 |
| 10 | 53 | 49 | 45 | 41 | 37 | 33 | 29 | 26 | 10 | 9 | 11 | 13 | 15 | 17 | 8 1 |
| 20 | 51 | 47 | 43 | 39 | 35 | 31 | 27 | 23 | 20 | 19 | 21 | 22 | 24 | 26 | 9 2 |
| 30 | 48 | 44 | 40 | 36 | 32 | 28 | 24 | 20 | 30 | 28 | 30 | 32 | 34 | 35 | |
| 40 | 46 | 42 | 38 | 33 | 29 | 25 | 21 | 17 | 40 | 37 | 39 | 41 | 43 | 45 | |
| 50 | 43 | 39 | 35 | 31 | 27 | 22 | 18 | 14 | 50 | 47 | 49 | 50 | 52 | 54 | |
| 22 0 | 47 42 | 48 37 | 49 33 | 50 29 | 51 25 | 52 20 | 53 16 | 54 11 | 0 | 0 | 2 | 4 | 6 | 7 | |
| 10 | 40 | 35 | 30 | 26 | 22 | 17 | 13 | 8 | 10 | 9 | 11 | 13 | 15 | 17 | |
| 20 | 37 | 32 | 27 | 23 | 19 | 14 | 10 | 5 | 20 | 19 | 20 | 22 | 24 | 26 | |
| 30 | 34 | 30 | 25 | 20 | 16 | 11 | 7 | 3 | 30 | 28 | 30 | 31 | 33 | 35 | |
| 40 | 32 | 27 | 22 | 18 | 13 | 9 | 4 | 0 | 40 | 37 | 39 | 41 | 43 | 45 | |
| 50 | 29 | 25 | 20 | 15 | 11 | 6 | 1 | 53 57 | 50 | 46 | 48 | 50 | 52 | 54 | |
| 23 0 | 47 27 | 48 22 | 49 17 | 50 13 | 51 8 | 52 3 | 52 58 | 53 54 | 0 | 0 | 2 | 4 | 6 | 7 | |
| 10 | 25 | 20 | 15 | 10 | 5 | 0 | 55 | 51 | 10 | 9 | 11 | 13 | 15 | 17 | |
| 20 | 22 | 17 | 12 | 7 | 2 | 51 57 | 52 | 48 | 20 | 18 | 20 | 22 | 24 | 26 | |
| 30 | 19 | 14 | 9 | 4 | 0 | 54 | 49 | 45 | 30 | 28 | 29 | 31 | 33 | 35 | |
| 40 | 16 | 11 | 6 | 1 | 50 57 | 51 | 46 | 42 | 40 | 37 | 39 | 40 | 42 | 44 | |
| 50 | 13 | 8 | 3 | 49 58 | 54 | 48 | 43 | 38 | 50 | 46 | 48 | 50 | 51 | 53 | |
| 24 0 | 47 10 | 48 5 | 49 0 | 49 55 | 50 50 | 51 45 | 52 40 | 53 35 | 0 | 0 | 2 | 4 | 5 | 7 | 1 0 |
| 10 | 8 | 3 | 48 57 | 52 | 47 | 42 | 37 | 32 | 10 | 9 | 11 | 13 | 15 | 16 | 2 1 |
| 20 | 5 | 0 | 54 | 49 | 44 | 39 | 33 | 28 | 20 | 18 | 20 | 22 | 24 | 26 | 3 1 |
| 30 | 2 | 47 57 | 51 | 46 | 41 | 35 | 30 | 24 | 30 | 27 | 29 | 30 | 32 | 34 | 4 1 |
| 40 | 46 59 | 54 | 48 | 43 | 38 | 32 | 27 | 21 | 40 | 36 | 38 | 40 | 42 | 44 | 5 2 |
| 50 | 56 | 51 | 45 | 40 | 35 | 29 | 23 | 18 | 50 | 46 | 47 | 49 | 51 | 53 | 6 2 |
| 25 0 | 46 53 | 47 48 | 48 42 | 49 37 | 50 31 | 51 26 | 52 20 | 53 14 | 0 | 0 | 2 | 4 | 5 | 7 | 7 2 |
| 10 | 50 | 45 | 39 | 33 | 28 | 22 | 16 | 10 | 10 | 9 | 11 | 13 | 14 | 16 | 8 2 |
| 20 | 46 | 41 | 35 | 29 | 24 | 18 | 12 | 6 | 20 | 18 | 20 | 22 | 24 | 25 | 9 3 |
| 30 | 43 | 38 | 32 | 26 | 20 | 14 | 8 | 3 | 30 | 27 | 29 | 31 | 33 | 34 | |
| 40 | 40 | 34 | 28 | 23 | 17 | 11 | 5 | 52 59 | 40 | 36 | 38 | 40 | 42 | 43 | |
| 50 | 37 | 31 | 25 | 19 | 14 | 7 | 1 | 56 | 50 | 45 | 47 | 49 | 51 | 52 | |
| 26 0 | 46 34 | 47 28 | 48 22 | 49 16 | 50 10 | 51 4 | 51 58 | 52 52 | 0 | 0 | 2 | 4 | 5 | 7 | |
| 10 | 31 | 25 | 19 | 13 | 7 | 1 | 54 | 48 | 10 | 9 | 11 | 13 | 14 | 16 | |
| 20 | 27 | 21 | 15 | 9 | 3 | 50 57 | 50 | 44 | 20 | 18 | 20 | 22 | 23 | 25 | |
| 30 | 24 | 18 | 12 | 6 | 49 59 | 53 | 46 | 40 | 30 | 27 | 29 | 31 | 32 | 34 | |
| 40 | 20 | 14 | 8 | 2 | 55 | 49 | 42 | 36 | 40 | 36 | 38 | 39 | 41 | 43 | |
| 50 | 17 | 11 | 4 | 48 58 | 51 | 45 | 38 | 32 | 50 | 45 | 47 | 48 | 50 | 52 | |
| 27 0 | 46 14 | 47 7 | 48 1 | 48 54 | 49 48 | 50 41 | 51 35 | 52 28 | 0 | 0 | 2 | 4 | 5 | 7 | 1 0 |
| 10 | 11 | 4 | 47 58 | 51 | 44 | 37 | 31 | 24 | 10 | 9 | 11 | 12 | 14 | 16 | 2 1 |
| 20 | 7 | 1 | 54 | 47 | 40 | 33 | 27 | 20 | 20 | 18 | 20 | 21 | 23 | 25 | 3 1 |
| 30 | 3 | 46 57 | 50 | 43 | 36 | 29 | 23 | 16 | 30 | 27 | 28 | 30 | 32 | 34 | 4 1 |
| 40 | 45 59 | 53 | 46 | 39 | 32 | 25 | 19 | 12 | 40 | 36 | 37 | 39 | 41 | 43 | 5 2 |
| 50 | 56 | 49 | 42 | 35 | 28 | 21 | 15 | 8 | 50 | 44 | 46 | 48 | 50 | 52 | 6 2 |
| 28 0 | 45 53 | 46 46 | 47 38 | 48 31 | 49 24 | 50 17 | 51 11 | 52 4 | 0 | 0 | 2 | 4 | 5 | 7 | 7 3 |
| 10 | 49 | 42 | 34 | 27 | 20 | 13 | 6 | 51 59 | 10 | 9 | 11 | 12 | 14 | 16 | 8 3 |
| 20 | 45 | 38 | 30 | 23 | 16 | 9 | 2 | 55 | 20 | 18 | 19 | 21 | 23 | 25 | 9 3 |
| 30 | 41 | 34 | 26 | 19 | 12 | 5 | 50 57 | 50 | 30 | 26 | 28 | 30 | 32 | 33 | |
| 40 | 37 | 30 | 23 | 15 | 8 | 1 | 54 | 46 | 40 | 35 | 37 | 39 | 41 | 42 | |
| 50 | 34 | 26 | 19 | 11 | 4 | 49 57 | 49 | 42 | 50 | 44 | 46 | 48 | 49 | 51 | |
| 29 0 | 45 30 | 46 22 | 47 15 | 48 7 | 49 0 | 49 53 | 50 45 | 51 38 | 0 | 0 | 2 | 4 | 5 | 7 | |
| 10 | 26 | 18 | 11 | 3 | 48 56 | 49 | 40 | 34 | 10 | 9 | 10 | 12 | 14 | 16 | |
| 20 | 22 | 14 | 7 | 47 59 | 52 | 44 | 36 | 29 | 20 | 17 | 19 | 21 | 23 | 24 | |
| 30 | 18 | 10 | 2 | 55 | 47 | 39 | 31 | 24 | 30 | 26 | 28 | 30 | 31 | 33 | |
| 40 | 14 | 6 | 46 58 | 51 | 43 | 35 | 27 | 20 | 40 | 35 | 37 | 38 | 40 | 42 | |
| 50 | 11 | 3 | 55 | 47 | 39 | 31 | 23 | 15 | 50 | 44 | 45 | 47 | 49 | 51 | |

TABLE 24. [Page 533

## Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

| Moon's app. alt. | Horizontal parallax. | | | | | | | | Seconds of parallax. | Correction for seconds of parallax.—Add. | | | | | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | | 0" | 2" | 4" | 6" | 8" | |
| ° ' | ' " | ' " | ' " | ' " | ' " | ' " | ' " | ' " | " | " | " | " | " | " | Sub. |
| 30 0 | 45 6 | 45 57 | 46 50 | 47 42 | 48 34 | 49 26 | 50 18 | 51 10 | 0 | 0 | 2 | 3 | 5 | 7 | 1' 0" |
| 10 | 2 | 54 | 46 | 38 | 30 | 22 | 13 | 6 | 10 | 9 | 10 | 12 | 14 | 16 | 2 1 |
| 20 | 44 58 | 50 | 42 | 34 | 26 | 18 | 9 | 1 | 20 | 17 | 19 | 21 | 23 | 24 | 3 1 |
| 30 | 54 | 46 | 37 | 29 | 21 | 13 | 4 | 50 56 | 30 | 26 | 28 | 29 | 31 | 33 | 4 2 |
| 40 | 50 | 42 | 33 | 25 | 17 | 8 | 0 | 52 | 40 | 35 | 36 | 38 | 40 | 42 | 5 2 |
| 50 | 45 | 38 | 29 | 21 | 12 | 4 | 49 55 | 47 | 50 | 43 | 45 | 47 | 49 | 50 | 6 3 |
| 31 0 | 44 41 | 45 33 | 46 24 | 47 16 | 48 7 | 48 59 | 49 50 | 50 42 | 0 | 0 | 2 | 3 | 5 | 7 | 7 3 |
| 10 | 37 | 29 | 20 | 12 | 2 | 54 | 45 | 37 | 10 | 9 | 10 | 12 | 14 | 15 | 8 4 |
| 20 | 33 | 24 | 15 | 7 | 47 58 | 49 | 40 | 32 | 20 | 17 | 19 | 21 | 22 | 24 | 9 4 |
| 30 | 28 | 20 | 11 | 2 | 54 | 45 | 36 | 27 | 30 | 26 | 27 | 29 | 31 | 32 | |
| 40 | 24 | 16 | 7 | 46 58 | 49 | 40 | 31 | 22 | 40 | 34 | 36 | 38 | 39 | 41 | |
| 50 | 20 | 11 | 2 | 53 | 44 | 35 | 26 | 17 | 50 | 43 | 44 | 46 | 48 | 50 | |
| 32 0 | 44 15 | 45 7 | 45 58 | 46 49 | 47 40 | 48 31 | 49 22 | 50 13 | 0 | 0 | 2 | 3 | 5 | 7 | |
| 10 | 11 | 3 | 53 | 44 | 35 | 26 | 17 | 8 | 10 | 8 | 10 | 12 | 14 | 15 | |
| 20 | 7 | 44 58 | 48 | 39 | 30 | 21 | 11 | 2 | 20 | 17 | 19 | 20 | 22 | 24 | |
| 30 | 3 | 53 | 44 | 34 | 25 | 16 | 6 | 49 57 | 30 | 25 | 27 | 29 | 30 | 32 | |
| 40 | 43 58 | 48 | 39 | 29 | 20 | 11 | 1 | 52 | 40 | 34 | 35 | 37 | 39 | 41 | |
| 50 | 54 | 44 | 34 | 24 | 15 | 6 | 48 56 | 47 | 50 | 42 | 44 | 46 | 47 | 49 | |
| 33 0 | 43 48 | 44 39 | 45 29 | 46 19 | 47 10 | 48 0 | 48 50 | 49 41 | 0 | 0 | 2 | 3 | 5 | 7 | 1 0 |
| 10 | 44 | 34 | 25 | 15 | 5 | 47 55 | 45 | 36 | 10 | 8 | 10 | 12 | 13 | 15 | 2 1 |
| 20 | 40 | 30 | 20 | 10 | 0 | 50 | 40 | 31 | 20 | 17 | 18 | 20 | 22 | 23 | 3 1 |
| 30 | 35 | 25 | 15 | 5 | 46 55 | 45 | 35 | 25 | 30 | 25 | 27 | 28 | 30 | 32 | 4 2 |
| 40 | 30 | 20 | 10 | 0 | 50 | 40 | 30 | 20 | 40 | 33 | 35 | 37 | 38 | 40 | 5 2 |
| 50 | 25 | 15 | 5 | 45 55 | 45 | 35 | 24 | 14 | 50 | 42 | 43 | 45 | 47 | 48 | 6 3 |
| 34 0 | 43 21 | 44 11 | 45 0 | 45 50 | 46 40 | 47 30 | 48 19 | 49 9 | 0 | 0 | 2 | 3 | 5 | 7 | 7 3 |
| 10 | 16 | 6 | 44 55 | 45 | 34 | 24 | 14 | 3 | 10 | 8 | 10 | 12 | 13 | 15 | 8 4 |
| 20 | 11 | 1 | 50 | 40 | 29 | 19 | 9 | 48 58 | 20 | 17 | 18 | 20 | 21 | 23 | 9 4 |
| 30 | 6 | 43 56 | 45 | 35 | 24 | 13 | 3 | 52 | 30 | 25 | 26 | 28 | 30 | 31 | |
| 40 | 1 | 51 | 40 | 30 | 19 | 8 | 47 58 | 47 | 40 | 33 | 35 | 36 | 38 | 40 | |
| 50 | 42 56 | 46 | 35 | 24 | 14 | 3 | 52 | 42 | 50 | 41 | 43 | 44 | 46 | 48 | |
| 35 0 | 42 52 | 43 41 | 44 30 | 45 19 | 46 9 | 46 58 | 47 47 | 48 36 | 0 | 0 | 2 | 3 | 5 | 7 | |
| 10 | 47 | 36 | 25 | 14 | 3 | 52 | 41 | 30 | 10 | 8 | 10 | 11 | 13 | 15 | |
| 20 | 42 | 31 | 20 | 9 | 45 58 | 47 | 36 | 25 | 20 | 16 | 18 | 20 | 21 | 23 | |
| 30 | 37 | 26 | 15 | 3 | 52 | 41 | 30 | 19 | 30 | 24 | 26 | 28 | 29 | 31 | |
| 40 | 32 | 21 | 10 | 44 58 | 47 | 36 | 25 | 14 | 40 | 33 | 34 | 36 | 38 | 39 | |
| 50 | 27 | 16 | 4 | 53 | 42 | 30 | 19 | 8 | 50 | 41 | 42 | 44 | 46 | 47 | |
| 36 0 | 42 22 | 43 11 | 43 59 | 44 48 | 45 37 | 46 25 | 47 14 | 48 2 | 0 | 0 | 2 | 3 | 5 | 6 | |
| 10 | 17 | 5 | 54 | 42 | 31 | 19 | 8 | 47 56 | 10 | 8 | 10 | 11 | 13 | 14 | 1 1 |
| 20 | 12 | 0 | 48 | 37 | 25 | 14 | 2 | 50 | 20 | 16 | 18 | 19 | 21 | 23 | 2 1 |
| 30 | 7 | 42 55 | 43 | 31 | 20 | 8 | 46 56 | 44 | 30 | 24 | 26 | 27 | 29 | 31 | 3 2 |
| 40 | 1 | 50 | 38 | 26 | 14 | 2 | 50 | 39 | 40 | 32 | 34 | 35 | 37 | 39 | 4 2 |
| 50 | 41 56 | 44 | 32 | 20 | 8 | 45 56 | 44 | 33 | 50 | 40 | 42 | 43 | 45 | 47 | 5 3 |
| 37 0 | 41 51 | 42 39 | 43 27 | 44 15 | 45 3 | 45 51 | 46 39 | 47 27 | 0 | 0 | 2 | 3 | 5 | 6 | 6 3 |
| 10 | 46 | 34 | 21 | 9 | 44 57 | 45 | 33 | 21 | 10 | 8 | 10 | 11 | 13 | 14 | 7 4 |
| 20 | 41 | 29 | 16 | 4 | 52 | 40 | 27 | 15 | 20 | 16 | 17 | 19 | 21 | 22 | 8 4 |
| 30 | 35 | 23 | 11 | 43 58 | 46 | 34 | 21 | 9 | 30 | 24 | 25 | 27 | 29 | 30 | 9 5 |
| 40 | 30 | 18 | 5 | 53 | 40 | 28 | 15 | 3 | 40 | 32 | 33 | 35 | 37 | 38 | |
| 50 | 25 | 12 | 42 59 | 47 | 34 | 22 | 9 | 46 57 | 50 | 40 | 41 | 43 | 45 | 46 | |
| 38 0 | 41 19 | 42 7 | 42 54 | 43 41 | 44 29 | 45 16 | 46 3 | 46 51 | 0 | 0 | 2 | 3 | 5 | 6 | |
| 10 | 14 | 2 | 49 | 36 | 23 | 10 | 45 57 | 45 | 10 | 8 | 9 | 11 | 13 | 14 | |
| 20 | 8 | 41 56 | 43 | 30 | 17 | 4 | 51 | 38 | 20 | 16 | 17 | 19 | 20 | 22 | |
| 30 | 3 | 51 | 38 | 24 | 12 | 44 58 | 45 | 32 | 30 | 23 | 25 | 27 | 28 | 30 | |
| 40 | 40 58 | 45 | 32 | 18 | 6 | 52 | 39 | 26 | 40 | 31 | 33 | 35 | 36 | 38 | |
| 50 | 52 | 39 | 26 | 13 | 0 | 46 | 33 | 20 | 50 | 39 | 41 | 42 | 44 | 46 | |
| 39 0 | 40 47 | 41 33 | 42 20 | 43 7 | 43 54 | 44 40 | 45 27 | 46 13 | 0 | 0 | 2 | 3 | 5 | 6 | 1 1 |
| 10 | 42 | 28 | 15 | 1 | 48 | 34 | 21 | 7 | 10 | 8 | 9 | 11 | 12 | 14 | 2 1 |
| 20 | 36 | 23 | 9 | 42 55 | 42 | 28 | 15 | 1 | 20 | 15 | 17 | 19 | 20 | 22 | 3 2 |
| 30 | 30 | 17 | 3 | 49 | 36 | 22 | 8 | 45 54 | 30 | 23 | 25 | 26 | 28 | 29 | 4 2 |
| 40 | 25 | 11 | 41 57 | 43 | 30 | 16 | 2 | 48 | 40 | 31 | 32 | 34 | 36 | 37 | 5 3 |
| 50 | 19 | 5 | 51 | 37 | 23 | 9 | 44 55 | 42 | 50 | 39 | 40 | 42 | 43 | 45 | |

# TABLE 24.

## Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

| Moon's app. alt. | Horizontal parallax. 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | Seconds of parallax | Correction for seconds of parallax.—Add. 0" | 2" | 4" | 6" | 8" | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40  0 | 40 14 | 41  0 | 41 46 | 42 32 | 43 18 | 44  4 | 44 50 | 45 36 | 0 | 0 | 2 | 3 | 5 | 6 | Sub. 6'  3" |
| 10 | ·8 | 40 54 | 39 | 25 | 11 | 43 57 | 43 | 29 | 10 | 8 | 9 | 11 | 12 | 14 | 7  4 |
| 20 | 2 | 48 | 33 | 19 | 5 | 50 | 36 | 22 | 20 | 15 | 17 | 18 | 20 | 21 | 8  5 |
| 30 | 39 56 | 42 | 28 | 13 | 42 59 | 44 | 30 | 16 | 30 | 23 | 24 | 26 | 27 | 29 | 9  5 |
| 40 | 50 | 36 | 22 | 7 | 53 | 38 | 24 | 9 | 40 | 30 | 32 | 34 | 35 | 37 | |
| 50 | 45 | 30 | 16 | 1 | 47 | 32 | 18 | 3 | 50 | 38 | 40 | 41 | 43 | 44 | |
| 41  0 | 39 39 | 40 24 | 41 10 | 41 55 | 42 41 | 43 26 | 44 11 | 44 56 | 0 | 0 | 2 | 3 | 5 | 6 | |
| 10 | 33 | 18 | 4 | 49 | 34 | 19 | 4 | 49 | 10 | 8 | 9 | 11 | 12 | 14 | |
| 20 | 27 | 12 | 40 58 | 43 | 28 | 13 | 43 58 | 43 | 20 | 15 | 17 | 18 | 20 | 21 | |
| 30 | 21 | 6 | 51 | 36 | 22 | 7 | 51 | 37 | 30 | 23 | 24 | 26 | 27 | 29 | |
| 40 | 16 | 0 | 45 | 30 | 16 | 0 | 45 | 30 | 40 | 30 | 32 | 33 | 35 | 36 | |
| 50 | 10 | 39 54 | 39 | 24 | 9 | 42 53 | 38 | 23 | 50 | 38 | 39 | 41 | 42 | 44 | |
| 42  0 | 39  4 | 39 48 | 40 33 | 41 17 | 42  2 | 42 47 | 43 31 | 44 16 | 0 | 0 | 1 | 3 | 4 | 6 | |
| 10 | 38 58 | 42 | 27 | 11 | 41 56 | 41 | 25 | 10 | 10 | 7 | 9 | 10 | 12 | 13 | 1  1 |
| 20 | ·52 | 36 | 21 | 5 | 50 | 34 | 18 | 3 | 20 | 15 | 16 | 18 | 19 | 21 | 2  1 |
| 30 | 46 | 30 | 14 | 40 58 | 43 | 27 | 11 | 43 56 | 30 | 22 | 24 | 25 | 27 | 28 | 3  2 |
| 40 | 40 | 24 | 8 | 52 | 36 | 21 | 5 | 49 | 40 | 30 | 31 | 33 | 34 | 36 | 4  2 |
| 50 | 34 | 18 | 2 | 46 | 30 | 14 | 42 58 | 42 | 50 | 37 | 38 | 40 | 41 | 43 | 5  3 |
| 43  0 | 38 28 | 39 12 | 39 56 | 40 40 | 41 24 | 42  8 | 42 52 | 43 36 | 0 | 0 | 1 | 3 | 4 | 6 | 6  4 |
| 10 | 22 | 6 | 50 | 34 | 18 | 1 | 45 | 29 | 10 | 7 | 9 | 10 | 12 | 13 | 7  4 |
| 20 | 16 | 38 59 | 43 | 27 | 11 | 41 54 | 38 | 22 | 20 | 15 | 16 | 18 | 19 | 20 | 8  5 |
| 30 | 10 | 53 | 37 | 20 | 5 | 48 | 31 | 15 | 30 | 22 | 23 | 25 | 26 | 28 | 9  5 |
| 40 | 4 | 47 | 30 | 14 | 40 58 | 41 | 24 | 8 | 40 | 29 | 31 | 32 | 34 | 35 | |
| 50 | 37 57 | 41 | 24 | 7 | 51 | 34 | 17 | 1 | 50 | 37 | 38 | 39 | 41 | 42 | |
| 44  0 | 37 51 | 38 35 | 39 18 | 40  1 | 40 44 | 41 27 | 42 10 | 42 54 | 0 | 0 | 1 | 3 | 4 | 6 | |
| 10 | 45 | 28 | 11 | 39 54 | 37 | 20 | 3 | 46 | 10 | 7 | 9 | 10 | 11 | 13 | |
| 20 | 38 | 21 | 4 | 47 | 30 | 13 | 41 56 | 39 | 20 | 14 | 16 | 17 | 19 | 20 | |
| 30 | 32 | 15 | 38 58 | 41 | 24 | 7 | 49 | 32 | 30 | 21 | 23 | 24 | 26 | 27 | |
| 40 | 26 | 9 | 51 | 34 | 17 | 0 | 42 | 25 | 40 | 29 | 30 | 31 | 33 | 34 | |
| 50 | 20 | 2 | 44 | 27 | 10 | 40 53 | 35 | 18 | 50 | 36 | 37 | 39 | 40 | 41 | |
| 45  0 | 37 14 | 37 56 | 38 38 | 39 21 | 40  3 | 40 46 | 41 28 | 42 11 | 0 | 0 | 1 | 3 | 4 | 6 | 1  1 |
| 10 | 7 | 49 | 31 | 14 | 39 56 | 39 | 21 | 3 | 10 | 7 | 8 | 10 | 11 | 13 | 2  1 |
| 20 | 0 | 43 | 25 | 7 | 49 | 32 | 14 | 41 56 | 20 | 14 | 15 | 17 | 18 | 20 | 3  2 |
| 30 | 36 54 | 37 | 18 | 1 | 43 | 25 | 7 | 49 | 30 | 21 | 23 | 24 | 25 | 27 | 4  3 |
| 40 | 48 | 30 | 11 | 38 54 | 36 | 18 | 0 | 42 | 40 | 28 | 30 | 31 | 32 | 34 | 5  3 |
| 50 | 41 | 23 | 4 | 47 | 29 | 11 | 40 52 | 34 | 50 | 35 | 37 | 38 | 39 | 41 | 6  4 |
| 46  0 | 36 35 | 37 17 | 37 58 | 38 40 | 39 22 | 40  4 | 40 45 | 41 27 | 0 | 0 | 1 | 3 | 4 | 6 | 7  5 |
| 10 | 29 | 10 | 51 | 33 | 15 | 39 57 | 38 | 20 | 10 | 7 | 8 | 10 | 11 | 12 | 8  5 |
| 20 | 22 | 3 | 44 | 26 | 8 | 49 | 31 | 12 | 20 | 14. | 15 | 17 | 18 | 19 | 9  6 |
| 30 | 16 | 36 57 | 38 | 20 | 1 | 42 | 24 | 5 | 30 | 21 | 22 | 23 | 25 | 26 | |
| 40 | 9 | 50 | 32 | 13 | 38 54 | 35 | 17 | 40 58 | 40 | 28 | 29 | 30 | 32 | 33 | |
| 50 | 2 | ·43 | 25 | 6 | 47 | 28 | 9 | 50 | 50 | 35 | 36 | 37 | 39 | 40 | |
| 47  0 | 35 56 | 36 37 | 37 18 | 37 59 | 38 40 | 39 21 | 40  2 | 40 43 | 0 | 0 | 1 | 3 | 4 | 5 | |
| 10 | 49 | 30 | 11 | 52 | 34 | 14 | 39 55 | 36 | 10 | 7 | 8 | 10 | 11 | 12 | |
| 20 | 42 | 23 | 4 | 45 | 26 | 6 | 47 | 28 | 20 | 14 | 15 | 16 | 18 | 19 | |
| 30 | 36 | 17 | 36 57 | 38 | 19 | 38 59 | 40 | 21 | 30 | 20 | 22 | 23 | 24 | 26 | |
| 40 | 30 | 10 | 50 | 31 | 12 | 52 | 32 | 13 | 40 | 27 | 29 | 30 | 31 | 33 | |
| 50 | 23 | 3 | 43 | 24 | 5 | 45 | 25 | 5 | 50 | 34 | 35 | 37 | 38 | 39 | |
| 48  0 | 35 16 | 35 56 | 36 36 | 37 17 | 37 57 | 38 37 | 39 17 | 39 58 | 0 | 0 | 1 | 3 | 4 | 5 | 1  1 |
| 10 | 10 | 50 | 30 | 10 | 50 | 30 | 10 | 50 | 10 | 7 | 8 | 9 | 11 | 12 | 2  1 |
| 20 | 3 | 43 | 23 | 2 | 43 | 22 | 2 | 42 | 20 | 13 | 15 | 16 | 17 | 19 | 3  2 |
| 30 | 34 56 | 36 | 16 | 36 55 | 35 | 15 | 38 55 | 34 | 30 | 20 | 21 | 23 | 24 | 25 | 4  3 |
| 40 | 49 | 29 | 9 | 48 | 28 | 8 | 48 | 27 | 40 | 27 | 28 | 29 | 31 | 32 | 5  3 |
| 50 | 42 | 22 | 1 | 41 | 21 | 0 | 40 | 19 | 50 | 33 | 35 | 36 | 37 | 39 | 6  4 |
| 49  0 | 34 35 | 35 15 | 35 54 | 36 34 | 37 13 | 37 53 | 38 32 | 39 11 | 0 | 0 | 1 | 3 | 4 | 5 | 7  5 |
| 10 | 29 | 8 | 47 | 27 | 6 | 46 | 25 | .4 | 10 | 7 | 8 | 9 | 10 | 12 | 8  5 |
| 20 | 22 | 1 | 40 | 20 | 36 59 | 38 | 17 | 38 56 | 20 | 13 | 14 | 16 | 17 | 18 | 9  6 |
| 30 | 15 | 34 54 | 33 | 12 | 51 | 30 | 9 | 48 | 30 | 20 | 21 | 22 | 23 | 25 | |
| 40 | 8 | 47 | 26 | 5 | 44 | 23 | 2 | 41 | 40 | 26 | 27 | 29 | 30 | 31 | |
| 50 | 1 | 40 | 19 | 35 58 | 36 | .15 | 37 54 | 33 | 50 | 33 | 34 | 35 | 36 | 38 | |

TABLE 24. [Page 535

## Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

Horizontal parallax / Correction for seconds of parallax.—Add.

| Moon's app. alt. | 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | Seconds of parallax | 0" | 2" | 4" | 6" | 8" | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 0 | 33 54 | 34 33 | 35 11 | 35 50 | 36 29 | 37 8 | 37 46 | 38 25 | 0 | 0 | 1 | 3 | 4 | 5 | |
| 10 | 47 | 26 | 4 | 43 | 21 | 37 0 | 38 | 17 | 10 | 6 | 8 | 9 | 10 | 12 | |
| 20 | 40 | 19 | 34 57 | 36 | 14 | 36 53 | 31 | 9 | 20 | 13 | 14 | 15 | 17 | 18 | |
| 30 | 33 | 11 | 49 | 28 | 6 | 45 | 23 | 1 | 30 | 19 | 20 | 22 | 23 | 24 | |
| 40 | 26 | 4 | 42 | 20 | 35 58 | 37 | 15 | 37 53 | 40 | 26 | 27 | 28 | 29 | 31 | |
| 50 | 19 | 33 57 | 35 | 13 | 51 | 29 | 7 | 45 | 50 | 32 | 33 | 35 | 36 | 37 | Sub. |
| 51 0 | 33 12 | 33 50 | 34 28 | 35 6 | 35 44 | 36 22 | 36 59 | 37 37 | 0 | 0 | 1 | 3 | 4 | 5 | 1' 1" |
| 10 | 5 | 43 | 21 | 34 58 | 36 | 14 | 51 | 29 | 10 | 6 | 8 | 9 | 10 | 11 | 2 1 |
| 20 | 32 58 | 36 | 13 | 50 | 28 | 36 6 | 43 | 21 | 20 | 13 | 14 | 15 | 16 | 18 | 3 2 |
| 30 | 51 | 29 | 6 | 43 | 21 | 35 58 | 36 | 13 | 30 | 19 | 20 | 21 | 23 | 24 | 4 3 |
| 40 | 44 | 22 | 33 59 | 36 | 14 | 50 | 28 | 5 | 40 | 25 | 26 | 28 | 29 | 30 | 5 4 |
| 50 | 37 | 14 | 51 | 28 | 6 | 42 | 20 | 36 57 | 50 | 31 | 33 | 34 | 35 | 36 | 6 4 |
| 52 0 | 32 30 | 33 7 | 33 44 | 34 21 | 34 58 | 35 35 | 36 12 | 36 49 | 0 | 0 | 1 | 2 | 4 | 5 | 7 5 |
| 10 | 23 | 33 0 | 36 | 13 | 50 | 27 | 4 | 41 | 10 | 6 | 7 | 9 | 10 | 11 | 8 6 |
| 20 | 15 | 32 52 | 29 | 6 | 43 | 19 | 35 56 | 33 | 20 | 12 | 13 | 15 | 16 | 17 | 9 6 |
| 30 | 8 | 45 | 21 | 33 58 | 35 | 11 | 48 | 24 | 30 | 18 | 20 | 21 | 22 | 23 | |
| 40 | 1 | 38 | 14 | 50 | 27 | 3 | 40 | 16 | 40 | 24 | 26 | 27 | 28 | 29 | |
| 50 | 31 54 | 31 | 7 | 43 | 19 | 34 55 | 32 | 8 | 50 | 31 | 32 | 33 | 34 | 35 | |
| 53 0 | 31 47 | 32 23 | 32 59 | 33 35 | 34 11 | 34 47 | 35 24 | 36 0 | 0 | 0 | 1 | 2 | 4 | 5 | |
| 10 | 39 | 15 | 51 | 27 | 34 3 | 39 | 35 15 | 35 51 | 10 | 6 | 7 | 8 | 10 | 11 | |
| 20 | 32 | 8 | 44 | 20 | 33 56 | 31 | 7 | 43 | 20 | 12 | 13 | 14 | 16 | 17 | |
| 30 | 25 | 33 0 | 36 | 12 | 48 | 23 | 34 59 | 35 | 30 | 18 | 19 | 20 | 22 | 23 | |
| 40 | 17 | 31 53 | 28 | 4 | 40 | 15 | 51 | 27 | 40 | 24 | 25 | 26 | 28 | 29 | |
| 50 | 10 | 46 | 21 | 32 57 | 32 | 7 | 43 | 19 | 50 | 30 | 31 | 32 | 34 | 35 | |
| 54 0 | 31 3 | 31 38 | 32 13 | 32 49 | 33 24 | 33 59 | 34 35 | 35 10 | 0 | 0 | 1 | 2 | 4 | 5 | |
| 10 | 30 55 | 30 | 5 | 41 | 16 | 51 | 26 | 35 1 | 10 | 6 | 7 | 8 | 9 | 11 | |
| 20 | 48 | 22 | 31 57 | 33 | 8 | 43 | 18 | 34 53 | 20 | 12 | 13 | 14 | 15 | 16 | |
| 30 | 40 | 15 | 49 | 25 | 33 0 | 35 | 10 | 45 | 30 | 18 | 19 | 20 | 21 | 22 | |
| 40 | 33 | 8 | 42 | 17 | 32 52 | 27 | 34 1 | 37 | 40 | 23 | 25 | 26 | 27 | 28 | |
| 50 | 26 | 30 0 | 35 | 9 | 44 | 19 | 33 53 | 28 | 50 | 29 | 30 | 32 | 33 | 34 | |
| 55 0 | 30 18 | 30 52 | 31 27 | 32 1 | 32 36 | 33 10 | 33 45 | 34 19 | 0 | 0 | 1 | 2 | 3 | 5 | |
| 10 | 10 | 45 | 19 | 31 53 | 28 | 33 2 | 36 | 11 | 10 | 6 | 7 | 8 | 9 | 10 | |
| 20 | 3 | 38 | 12 | 46 | 20 | 32 54 | 28 | 3 | 20 | 11 | 13 | 14 | 15 | 16 | |
| 30 | 29 55 | 30 | 4 | 38 | 12 | 46 | 20 | 33 54 | 30 | 17 | 18 | 19 | 20 | 22 | |
| 40 | 48 | 22 | 30 56 | 30 | 4 | 37 | 11 | 45 | 40 | 23 | 24 | 25 | 26 | 27 | |
| 50 | 40 | 14 | 48 | 22 | 31 55 | 29 | 3 | 37 | 50 | 28 | 30 | 31 | 32 | 33 | |
| 56 0 | 29 33 | 30 7 | 30 40 | 31 14 | 31 47 | 32 21 | 32 55 | 33 28 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 25 | 29 59 | 32 | 6 | 39 | 13 | 46 | 20 | 10 | 6 | 7 | 8 | 9 | 10 | |
| 20 | 18 | 51 | 24 | 30 58 | 31 | 4 | 37 | 11 | 20 | 11 | 12 | 13 | 14 | 16 | |
| 30 | 10 | 43 | 16 | 50 | 23 | 31 56 | 29 | 2 | 30 | 17 | 18 | 19 | 20 | 21 | 1 1 |
| 40 | 3 | 36 | 9 | 42 | 15 | 48 | 32 54 | 21 | 40 | 22 | 23 | 24 | 25 | 27 | 2 2 |
| 50 | 28 55 | 28 | 1 | 34 | 7 | 40 | 12 | 45 | 50 | 28 | 29 | 30 | 31 | 32 | 3 2 |
| 57 0 | 28 47 | 29 20 | 29 53 | 30 25 | 30 58 | 31 31 | 32 3 | 32 36 | 0 | 0 | 1 | 2 | 3 | 4 | 4 3 |
| 10 | 39 | 12 | 45 | 17 | 50 | 22 | 31 55 | 27 | 10 | 5 | 6 | 7 | 9 | 10 | 5 4 |
| 20 | 32 | 5 | 37 | 9 | 42 | 14 | 47 | 19 | 20 | 11 | 12 | 13 | 14 | 15 | 6 5 |
| 30 | 24 | 28 57 | 29 | 30 1 | 33 | 6 | 38 | 10 | 30 | 16 | 17 | 18 | 19 | 21 | 7 5 |
| 40 | 17 | 49 | 21 | 29 53 | 25 | 30 57 | 29 | 32 1 | 40 | 22 | 23 | 24 | 25 | 26 | 8 6 |
| 50 | 9 | 41 | 13 | 45 | 17 | 49 | 21 | 31 52 | 50 | 27 | 28 | 29 | 30 | 31 | 9 7 |
| 58 0 | 28 1 | 28 33 | 29 5 | 29 37 | 30 9 | 30 41 | 31 12 | 31 44 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 27 53 | 25 | 28 57 | 28 | 30 0 | 32 | 4 | 35 | 10 | 5 | 6 | 7 | 8 | 9 | |
| 20 | 45 | 17 | 49 | 20 | 29 52 | 23 | 30 55 | 26 | 20 | 10 | 12 | 13 | 14 | 15 | |
| 30 | 38 | 9 | 41 | 12 | 44 | 15 | 46 | 17 | 30 | 16 | 17 | 18 | 19 | 20 | |
| 40 | 30 | 28 1 | 33 | 4 | 35 | 6 | 38 | 9 | 40 | 21 | 22 | 23 | 24 | 25 | |
| 50 | 22 | 27 53 | 24 | 28 55 | 27 | 29 58 | 29 | 31 0 | 50 | 26 | 27 | 28 | 29 | 30 | |
| 59 0 | 27 14 | 27 45 | 28 16 | 28 47 | 29 18 | 29 49 | 30 20 | 30 51 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 6 | 37 | 7 | 38 | 9 | 40 | 11 | 42 | 10 | 5 | 6 | 7 | 8 | 9 | |
| 20 | 26 58 | 29 | 27 59 | 30 | 1 | 31 | 2 | 33 | 20 | 10 | 11 | 12 | 13 | 14 | |
| 30 | 51 | 21 | 51 | 22 | 28 53 | 23 | 29 54 | 24 | 30 | 15 | 16 | 17 | 18 | 19 | |
| 40 | 43 | 13 | 43 | 14 | 44 | 14 | 45 | 15 | 40 | 20 | 21 | 22 | 23 | 24 | |
| 50 | 35 | 5 | 35 | 5 | 36 | 6 | 36 | 6 | 50 | 25 | 26 | 27 | 29 | 30 | |

# TABLE 24.

### Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

| Moon's app. alt. | Horizontal parallax. | | | | | | | | Seconds of parallax. | Correction for seconds of parallax.—Add. | | | | | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | ″ | 0″ | 2″ | 4″ | 6″ | 8″ | |
| 60  0 | 26 26 | 26 57 | 27 27 | 27 57 | 28 27 | 28 57 | 29 27 | 29 57 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 19 | 49 | 19 | 49 | 19 | 49 | 18 | 48 | 10 | 5 | 6 | 7 | 8 | 9 | |
| 20 | 11 | 41 | 11 | 40 | 10 | 40 | 9 | 39 | 20 | 10 | 11 | 12 | 13 | 14 | |
| 30 | 3 | 32 | 2 | 31 | 1 | 31 | 0 | 30 | 30 | 15 | 16 | 17 | 18 | 19 | |
| 40 | 25 55 | 24 | 26 53 | 23 | 27 53 | 22 | 28 51 | 21 | 40 | 20 | 21 | 22 | 23 | 24 | |
| 50 | 47 | 16 | 45 | 14 | 44 | 13 | 42 | 12 | 50 | 25 | 26 | 27 | 28 | 29 | |
| 61  0 | 25 39 | 26 8 | 26 37 | 27 6 | 27 36 | 28 5 | 28 34 | 29 3 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 31 | 0 | 29 | 26 58 | 27 | 27 56 | 25 | 28 54 | 10 | 5 | 6 | 7 | 8 | 9 | |
| 20 | 23 | 25 52 | 20 | 49 | 18 | 47 | 16 | 45 | 20 | 10 | 11 | 12 | 12 | 13 | |
| 30 | 15 | 43 | 12 | 40 | 10 | 38 | 7 | 35 | 30 | 14 | 15 | 16 | 17 | 18 | |
| 40 | 7 | 35 | 4 | 32 | 1 | 29 | 27 58 | 26 | 40 | 19 | 20 | 21 | 22 | 23 | |
| 50 | 24 59 | 27 | 25 55 | 24 | 26 52 | 20 | 49 | 17 | 50 | 24 | 25 | 26 | 27 | 28 | |
| 62  0 | 24 50 | 25 19 | 25 47 | 26 15 | 26 43 | 27 11 | 27 40 | 28 8 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 42 | 10 | 38 | 6 | 34 | 2 | 30 | 27 58 | 10 | 5 | 6 | 6 | 7 | 8 | |
| 20 | 34 | 2 | 29 | 25 57 | 25 | 26 53 | 21 | 49 | 20 | 9 | 10 | 11 | 12 | 12 | |
| 30 | 26 | 24 54 | 21 | 49 | 17 | 45 | 12 | 40 | 30 | 14 | 15 | 16 | 17 | 18 | |
| 40 | 18 | 46 | 13 | 41 | 8 | 36 | 3 | 31 | 40 | 19 | 19 | 20 | 21 | 22 | |
| 50 | 10 | 37 | 4 | 32 | 25 59 | 27 | 26 54 | 21 | 50 | 23 | 24 | 25 | 26 | 27 | |
| 63  0 | 24 2 | 24 29 | 24 56 | 25 23 | 25 51 | 26 18 | 26 45 | 27 12 | 0 | 0 | 1 | 2 | 3 | 4 | |
| 10 | 23 54 | 21 | 48 | 15 | 42 | 9 | 36 | 3 | 10 | 4 | 5 | 6 | 7 | 8 | |
| 20 | 46 | 13 | 39 | 6 | 33 | 0 | 27 | 26 54 | 20 | 9 | 10 | 11 | 12 | 13 | |
| 30 | 37 | 4 | 31 | 24 58 | 24 | 25 51 | 18 | 45 | 30 | 13 | 14 | 15 | 16 | 17 | |
| 40 | 29 | 23 55 | 22 | 49 | 15 | 42 | 8 | 35 | 40 | 18 | 19 | 20 | 21 | 22 | |
| 50 | 20 | 47 | 13 | 40 | 6 | 33 | 25 59 | 26 | 50 | 22 | 23 | 24 | 25 | 26 | |
| 64  0 | 23 12 | 23 39 | 24 5 | 24 32 | 24 58 | 25 24 | 25 50 | 26 17 | 0 | 0 | 1 | 2 | 3 | 3 | |
| 10 | 4 | 31 | 23 57 | 23 | 49 | 15 | 41 | 8 | 10 | 4 | 5 | 6 | 7 | 8 | |
| 20 | 22 56 | 22 | 48 | 14 | 40 | 6 | 32 | 25 58 | 20 | 9 | 10 | 10 | 11 | 12 | |
| 30 | 47 | 13 | 39 | 5 | 31 | 24 57 | 22 | 48 | 30 | 13 | 14 | 15 | 16 | 16 | |
| 40 | 39 | 5 | 30 | 23 56 | 22 | 48 | 13 | 39 | 40 | 17 | 18 | 19 | 20 | 21 | |
| 50 | 31 | 22 57 | 22 | 48 | 13 | 39 | 4 | 30 | 50 | 22 | 23 | 23 | 24 | 25 | |
| 65  0 | 22 23 | 22 48 | 23 13 | 23 39 | 24 4 | 24 30 | 24 55 | 25 21 | 0 | 0 | 1 | 2 | 2 | 3 | Sub. |
| 10 | 14 | 40 | 5 | 30 | 23 55 | 20 | 46 | 11 | 10 | 4 | 5 | 6 | 7 | 7 | 1′ 1″ |
| 20 | 6 | 31 | 22 56 | 21 | 46 | 11 | 36 | 1 | 20 | 8 | 9 | 10 | 11 | 12 | 2 2 |
| 30 | 21 58 | 23 | 48 | 13 | 37 | 2 | 27 | 24 52 | 30 | 13 | 13 | 14 | 15 | 16 | 3 3 |
| 40 | 49 | 14 | 39 | 4 | 28 | 23 53 | 18 | 43 | 40 | 17 | 18 | 18 | 19 | 20 | 4 4 |
| 50 | 41 | 6 | 30 | 22 55 | 19 | 44 | 8 | 33 | 50 | 21 | 22 | 23 | 23 | 24 | 5 5 |
| 66  0 | 21 32 | 21 57 | 22 21 | 22 46 | 23 10 | 23 35 | 23 59 | 24 23 | 0 | 0 | 1 | 2 | 2 | 3 | 6 5 |
| 10 | 24 | 48 | 12 | 37 | 1 | 25 | 49 | 14 | 10 | 4 | 5 | 6 | 7 | 7 | 7 6 |
| 20 | 15 | 39 | 3 | 28 | 22 52 | 15 | 40 | 4 | 20 | 8 | 9 | 10 | 11 | 11 | 8 7 |
| 30 | 7 | 31 | 21 55 | 19 | 43 | 6 | 31 | 23 55 | 30 | 12 | 13 | 14 | 15 | 16 | 9 8 |
| 40 | 20 59 | 22 | 46 | 10 | 34 | 22 57 | 21 | 45 | 40 | 16 | 17 | 18 | 19 | 20 | |
| 50 | 50 | 14 | 37 | 1 | 25 | 48 | 12 | 36 | 50 | 20 | 21 | 22 | 23 | 24 | |
| 67  0 | 20 41 | 21 5 | 21 28 | 21 52 | 22 15 | 22 39 | 23 2 | 23 26 | 0 | 0 | 1 | 2 | 2 | 3 | |
| 10 | 33 | 20 56 | 19 | 43 | 6 | 29 | 22 52 | 16 | 10 | 4 | 5 | 5 | 6 | 7 | |
| 20 | 25 | 48 | 11 | 34 | 21 57 | 20 | 43 | 7 | 20 | 8 | 8 | 9 | 10 | 11 | |
| 30 | 16 | 39 | 2 | 25 | 48 | 11 | 34 | 22 57 | 30 | 12 | 12 | 13 | 14 | 15 | |
| 40 | 8 | 30 | 20 53 | 16 | 39 | 2 | 24 | 47 | 40 | 15 | 16 | 17 | 18 | 18 | |
| 50 | 19 59 | 21 | 44 | 7 | 30 | 21 52 | 15 | 37 | 50 | 19 | 20 | 21 | 22 | 22 | |
| 68  0 | 19 50 | 20 13 | 20 35 | 20 58 | 21 21 | 21 43 | 22 5 | 22 28 | 0 | 0 | 1 | 1 | 2 | 3 | |
| 10 | 42 | 4 | 27 | 49 | 12 | 34 | 21 56 | 19 | 10 | 4 | 4 | 5 | 6 | 7 | |
| 20 | 33 | 19 56 | 18 | 40 | 2 | 24 | 47 | 9 | 20 | 7 | 8 | 9 | 9 | 10 | |
| 30 | 25 | 47 | 9 | 31 | 20 53 | 15 | 37 | 21 59 | 30 | 11 | 12 | 13 | 13 | 14 | |
| 40 | 16 | 38 | 0 | 22 | 44 | 5 | 27 | 49 | 40 | 15 | 16 | 16 | 17 | 18 | |
| 50 | 7 | 29 | 19 51 | 13 | 34 | 20 56 | 17 | 39 | 50 | 18 | 19 | 20 | 21 | 21 | |
| 69  0 | 18 59 | 19 21 | 19 42 | 20 4 | 20 25 | 20 47 | 21 8 | 21 30 | 0 | 0 | 1 | 1 | 2 | 3 | |
| 10 | 50 | 12 | 33 | 19 55 | 16 | 37 | 20 59 | 20 | 10 | 4 | 4 | 5 | 6 | 6 | |
| 20 | 42 | 3 | 24 | 45 | 7 | 28 | 49 | 10 | 20 | 7 | 8 | 8 | 9 | 10 | |
| 30 | 33 | 18 54 | 15 | 36 | 19 57 | 18 | 39 | 0 | 30 | 11 | 11 | 12 | 13 | 13 | |
| 40 | 24 | 45 | 6 | 27 | 48 | 9 | 29 | 20 50 | 40 | 14 | 15 | 15 | 16 | 17 | |
| 50 | 16 | 37 | 18 57 | 18 | 39 | 0 | 20 | 41 | 50 | 18 | 18 | 19 | 20 | 20 | |

TABLE 24.                                    [Page 537

## Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

| Moon's app. alt. | Horizontal parallax. | | | | | | | | Seconds of parallax. | Correction for seconds of parallax.—Add. | | | | | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 54' | 55' | 56' | 57' | 58' | 59' | 60' | 61' | | 0" | 2" | 4" | 6" | 8" | |
| ° ' | ' " | ' " | ' " | ' " | ' " | ' " | ' " | ' " | " | " | " | " | " | " | |
| 70 0 | 18 7 | 18 28 | 18 48 | 19 9 | 19 30 | 19 50 | 20 11 | 20 31 | 0 | 0 | 1 | 1 | 2 | 3 | |
| 10 | 17 58 | 19 | 39 | 0 | 20 | 41 | 1 | 21 | 10 | 3 | 4 | 5 | 5 | 6 | |
| 20 | 50 | 10 | 30 | 18 50 | 11 | 31 | 19 51 | 11 | 20 | 7 | 7 | 8 | 9 | 9 | |
| 30 | 41 | 1 | 21 | 41 | 1 | 21 | 41 | 1 | 30 | 10 | 11 | 11 | 12 | 13 | |
| 40 | 32 | 17 53 | 12 | 32 | 18 52 | 12 | 32 | 19 52 | 40 | 13 | 14 | 15 | 15 | 16 | |
| 50 | 24 | 44 | 3 | 23 | 43 | 3 | 22 | 42 | 50 | 17 | 17 | 18 | 19 | 19 | |
| 71 0 | 17 15 | 17 35 | 17 54 | 18 14 | 18 34 | 18 53 | 19 12 | 19 32 | 0 | 0 | 1 | 1 | 2 | 3 | |
| 10 | 6 | 26 | 45 | 5 | 24 | 43 | 3 | 22 | 10 | 3 | 4 | 4 | 5 | 6 | |
| 20 | 16 57 | 17 | 36 | 17 55 | 14 | 33 | 18 53 | 12 | 20 | 6 | 7. | 8 | 8 | 9 | |
| 30 | 48 | 8 | 27 | 46 | 5 | 24 | 43 | 2 | 30 | 10 | 10 | 11 | 12 | 12 | |
| 40 | 40 | 16 59 | 18 | 37 | 17 56 | 15 | 34 | 18 52 | 40 | 13 | 13 | 14 | 15 | 15 | |
| 50 | 31 | 50 | 9 | 28 | 47 | 5 | 24 | 42 | 50 | 16 | 17 | 17 | 18 | 19 | |
| 72 0 | 16 22 | 16 41 | 17 0 | 17 18 | 17 37 | 17 55 | 18 14 | 18 32 | 0 | 0 | 1 | 1 | 2 | 2 | |
| 10 | 13 | 32 | 16 50 | 9 | 27 | 46 | 4 | 22 | 10 | 3 | 4 | 4 | 5 | 5 | |
| 20 | 5 | 23 | 41 | 16 59 | 18 | 36 | 17 54 | 12 | 20 | 6 | 7 | 7 | 8 | 8 | |
| 30 | 15 57 | 14 | 32 | 50 | 9 | 27 | 45 | 3 | 30 | 9 | 10 | 10 | 11 | 11 | |
| 40 | 48 | 5 | 23 | 41 | 16 59 | 17 | 35 | 17 53 | 40 | 12 | 13 | 13 | 14 | 14 | |
| 50 | 39 | 15 56 | 14 | 32 | 50 | 7 | 25 | 43 | 50 | 15 | 16 | 16 | 17 | 18 | |
| 73 0 | 15 30 | 15 47 | 16 5 | 16 22 | 16 40 | 16 58 | 17 15 | 17 33 | 0 | 0 | 1 | 1 | 2 | 2 | |
| 10 | 21 | 38 | 15 56 | 13 | 30 | 48 | 5 | 23 | 10 | 3 | 3 | 4 | 5 | 5 | |
| 20 | 12 | 29 | 47 | 4 | 21 | 39 | 16 56 | 13 | 20 | 6 | 6 | 7 | 7 | 8 | |
| 30 | 3 | 20 | 37 | 15 55 | 12 | 29 | 46 | 3 | 30 | 9 | 9 | 10 | 10 | 11 | |
| 40 | 14 54 | 11 | 28 | 45 | 2 | 19 | 36 | 16 53 | 40 | 11 | 12 | 13 | 13 | 14 | |
| 50 | 45 | 2 | 19 | 35 | 15 52 | 9 | 26 | 42 | 50 | 14 | 15 | 15 | 16 | 17 | |
| 74 0 | 14 36 | 14 53 | 15 9 | 15 26 | 15 42 | 15 59 | 16 16 | 16 32 | 0 | 0 | 1 | 1 | 2 | 2 | Sub. |
| 10 | 28 | 44 | 0 | 17 | 33 | 49 | 6 | 22 | 10 | 3 | 3 | 4 | 4 | 5 | 1' 1" |
| 20 | 19 | 35 | 14 51 | 8 | 24 | 40 | 15 56 | 12 | 20 | 5 | 6 | 6 | 7 | 8 | 2 2 |
| 30 | 10 | 26 | 42 | 14 58 | 14 | 30 | 46 | 2 | 30 | 8 | 9 | 9 | 10 | 11 | 3 3 |
| 40 | 1 | 17 | 33 | 49 | 5 | 20 | 36 | 15 52 | 40 | 11 | 11 | 12 | 12 | 13 | 4 4 |
| 50 | 13 52 | 8 | 23 | 39 | 14 55 | 10 | 26 | 42 | 50 | 13 | 14 | 14 | 15 | 16 | 5 5 |
| 75 0 | 13 43 | 13 59 | 14 14 | 14 29 | 14 45 | 15 1 | 15 16 | 15 32 | 0 | 0 | 1 | 1 | 2 | 2 | 6 6 |
| 10 | 34 | 50 | 5 | 20 | 36 | 14 52 | 7 | 22 | 10 | 3 | 3 | 4 | 4 | 5 | 7 7 |
| 20 | 25 | 41 | 13 56 | 11 | 27 | 42 | 14 57 | 12 | 20 | 5 | 6 | 6 | 7 | 7 | 8 8 |
| 30 | 16 | 32 | 46 | 1 | 17 | 32 | 47 | 2 | 30 | 8 | 8 | 9 | 9 | 10 | 9 9 |
| 40 | 7 | 22 | 37 | 13 52 | 7 | 22 | 37 | 14 51 | 40 | 10 | 11 | 11 | 12 | 12 | |
| 50 | 12 58 | 13 | 28 | 42 | 13 57 | 12 | 27 | 41 | 50 | 13 | 13 | 14 | 14 | 15 | |
| 76 0 | 12 49 | 13 4 | 13 18 | 13 33 | 13 47 | 14 2 | 14 17 | 14 31 | 0 | 0 | 0 | 1 | 1 | 2 | |
| 10 | 41 | 12 55 | 9 | 24 | 38 | 13 53 | 7 | 21 | 10 | 2 | 3 | 3 | 4 | 4 | |
| 20 | 32 | 46 | 0 | 14 | 28 | 43 | 13 57 | 11 | 20 | 5 | 5 | 6 | 6 | 7 | |
| 30 | 23 | 37 | 12 51 | 5 | 19 | 33 | 47 | 1 | 30 | 7 | 8 | 8 | 8 | 9 | |
| 40 | 14 | 27 | 41 | 12 55 | 9 | 23 | 36 | 13 50 | 40 | 9 | 10 | 10 | 11 | 11 | |
| 50 | 5 | 18 | 32 | 45 | 12 59 | 13 | 26 | 40 | 50 | 12 | 12 | 13 | 13 | 14 | |
| 77 0 | 11 56 | 12 9 | 12 22 | 12 36 | 12 49 | 13 3 | 13 16 | 13 30 | 0 | 0 | 0 | 1 | 1 | 2 | |
| 10 | 47 | 0 | 13 | 27 | 40 | 12 53 | 7 | 20 | 10 | 2 | 3 | 3 | 4 | 4 | |
| 20 | 38 | 11 51 | 4 | 17 | 30 | 43 | 12 57 | 10 | 20 | 4 | 5 | 5 | 6 | 6 | |
| 30 | 29 | 42 | 11 55 | 8 | 21 | 33 | 47 | 0 | 30 | 7 | 7 | 7 | 8 | 8 | |
| 40 | 19 | 32 | 45 | 11 58 | 11 | 23 | 36 | 12 49 | 40 | 9 | 9 | 9 | 10 | 10 | |
| 50 | 10 | 23 | 35 | 48 | 1 | 13 | 26 | 39 | 50 | 11 | 11 | 12 | 12 | 13 | |
| 78 0 | 11 1 | 11 14 | 11 26 | 11 39 | 11 52 | 12 4 | 12 16 | 12 29 | 0 | 0 | 0 | 1 | 1 | 2 | |
| 10 | 10 52 | 5 | 17 | 30 | 42 | 11 54 | 6 | 19 | 10 | 2 | 2 | 3 | 3 | 4 | |
| 20 | 43 | 10 55 | 8 | 20 | 32 | 44 | 11 56 | 8 | 20 | 4 | 4 | 5 | 5 | 6 | |
| 30 | 34 | 46 | 10 58 | 10 | 22 | 34 | 46 | 11 58 | 30 | 6 | 6 | 7 | 7 | 8 | |
| 40 | 25 | 37 | 48 | 0 | 12 | 24 | 36 | 48 | 40 | 8 | 8 | 9 | 9 | 10 | |
| 50 | 16 | 28 | 39 | 10 51 | 3 | 15 | 26 | 38 | 50 | 10 | 10 | 11 | 11 | 12 | |
| 79 0 | 10 7 | 10 19 | 10 30 | 10 42 | 10 53 | 11 5 | 11 16 | 11 28 | 0 | 0 | 0 | 1 | 1 | 1 | |
| 10 | 9 58 | 9 | 21 | 32 | 43 | 10 55 | 6 | 17 | 10 | 2 | 2 | 3 | 3 | 3 | |
| 20 | 49 | 0 | 11 | 22 | 33 | 44 | 10 56 | 7 | 20 | 4 | 4 | 4 | 5 | 5 | |
| 30 | 40 | 9 50 | 1 | 12 | 23 | 34 | 45 | 10 56 | 30 | 6 | 6 | 6 | 7 | 7 | |
| 40 | ·31 | 41 | 9 52 | 3 | 13 | 24 | 35 | 46 | 40 | 7 | 8 | 8 | 8 | 9 | |
| 50 | 22 | 32 | 43 | 9 54 | 4 | 15 | 25 | 36 | 50 | 9 | 10 | 10 | 10 | 11 | |

## TABLE 24.

### Correction of the Moon's Apparent Altitude for Parallax and Refraction.

[Barometer 30 inches.—Fahrenheit's Thermometer 50°.]

| Moon's app. alt. | Horizontal parallax. 54′ | 55′ | 56′ | 57′ | 58′ | 59′ | 60′ | 61′ | Seconds of parallax. | Correction for seconds of parallax.—Add. 0″ | 2″ | 4″ | 6″ | 8″ | Corr. for minutes of alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | |
| 80 0 | 9 13 | 9 23 | 9 34 | 9 44 | 9 55 | 10 5 | 10 15 | 10 26 | 0 | 0 | 0 | 1 | 1 | 1 | |
| 10 | 3 | 14 | 24 | 34 | 45 | 9 55 | 5 | 15 | 10 | 2 | 2 | 2 | 3 | 3 | |
| 20 | 8 54 | 4 | 14 | 24 | 35 | 45 | 9 55 | 5 | 20 | 3 | 4 | 4 | 4 | 5 | |
| 30 | 45 | 8 55 | 5 | 15 | 25 | 35 | 45 | 9 54 | 30 | 5 | 5 | 6 | 6 | 6 | |
| 40 | 36 | 46 | 8 55 | 5 | 15 | 25 | 35 | 44 | 40 | 7 | 7 | 7 | 8 | 8 | |
| 50 | 27 | 37 | 46 | 8 56 | 6 | 15 | 25 | 34 | 50 | 8 | 9 | 9 | 9 | 10 | |
| 81 0 | 8 18 | 8 27 | 8 37 | 8 46 | 8 56 | 9 5 | 9 14 | 9 24 | 0 | 0 | 0 | 1 | 1 | 1 | |
| 10 | 9 | 18 | 27 | 36 | 46 | 8 55 | 4 | 13 | 10 | 1 | 2 | 2 | 2 | 3 | |
| 20 | 7 59 | 8 | 17 | 26 | 36 | 45 | 8 54 | 3 | 20 | 3 | 3 | 4 | 4 | 4 | |
| 30 | 50 | 7 59 | 8 | 17 | 26 | 35 | 44 | 8 52 | 30 | 4 | 5 | 5 | 5 | 6 | |
| 40 | 41 | 50 | 7 59 | 8 | 17 | 25 | 34 | 42 | 40 | 6 | 6 | 6 | 7 | 7 | |
| 50 | 32 | 41 | 49 | 7 58 | 7 | 15 | 24 | 32 | 50 | 7 | 8 | 8 | 8 | 9 | |
| 82 0 | 7 23 | 7 31 | 7 40 | 7 48 | 7 57 | 8 5 | 8 13 | 8 22 | 0 | 0 | 0 | 1 | 1 | 1 | |
| 10 | 14 | 22 | 30 | 38 | 47 | 7 55 | 3 | 11 | 10 | 1 | 2 | 2 | 2 | 2 | |
| 20 | 4 | 12 | 20 | 28 | 37 | 45 | 7 52 | 0 | 20 | 3 | 3 | 3 | 3 | 4 | |
| 30 | 6 55 | 3 | 11 | 19 | 27 | 35 | 42 | 7 50 | 30 | 4 | 4 | 5 | 5 | 5 | |
| 40 | 46 | 6 54 | 2 | 10 | 17 | 25 | 32 | 40 | 40 | 5 | 6 | 6 | 6 | 6 | |
| 50 | 37 | 45 | 6 52 | 0 | 7 | 15 | 22 | 30 | 50 | 7 | 7 | 7 | 7 | 8 | |
| 83 0 | 6 28 | 6 35 | 6 43 | 6 50 | 6 57 | 7 5 | 7 12 | 7 20 | 0 | 0 | 0 | 0 | 1 | 1 | Sub. |
| 10 | 19 | 26 | 33 | 40 | 47 | 6 54 | 2 | 9 | 10 | 1 | 1 | 2 | 2 | 2 | 1′ 1″ |
| 20 | 9 | 16 | 23 | 30 | 37 | 44 | 6 51 | 6 58 | 20 | 2 | 3 | 3 | 3 | 3 | 2′ 2″ |
| 30 | 0 | 7 | 13 | 20 | 27 | 34 | 41 | 48 | 30 | 3 | 4 | 4 | 4 | 4 | 3′ 3″ |
| 40 | 5 51 | 5 58 | 4 | 11 | 18 | 24 | 31 | 38 | 40 | 5 | 5 | 5 | 5 | 6 | 4′ 4″ |
| 50 | 42 | 49 | 5 55 | 1 | 8 | 14 | 21 | 27 | 50 | 6 | 6 | 6 | 6 | 7 | 5′ 5″ |
| 84 0 | 5 33 | 5 39 | 5 45 | 5 52 | 5 58 | 6 4 | 6 10 | 6 17 | 0 | 0 | 0 | 0 | 1 | 1 | 6′ 6″ |
| 10 | 23 | 30 | 36 | 42 | 48 | 5 54 | 0 | 6 | 10 | 1 | 1 | 1 | 2 | 2 | 7′ 7″ |
| 20 | 14 | 20 | 26 | 32 | 38 | 44 | 5 50 | 5 55 | 20 | 2 | 2 | 2 | 3 | 3 | 8′ 8″ |
| 30 | 5 | 10 | 16 | 22 | 28 | 34 | 39 | 45 | 30 | 3 | 3 | 3 | 3 | 4 | 9′ 9″ |
| 40 | 4 56 | 1 | 7 | 13 | 18 | 24 | 29 | 35 | 40 | 4 | 4 | 4 | 4 | 5 | |
| 50 | 47 | 4 52 | 4 58 | 3 | 8 | 14 | 19 | 25 | 50 | 5 | 5 | 5 | 5 | 6 | |
| 85 0 | 4 37 | 4 43 | 4 48 | 4 53 | 4 58 | 5 4 | 5 9 | 5 14 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 10 | 28 | 33 | 38 | 43 | 48 | 4 53 | 4 58 | 3 | 10 | 1 | 1 | 1 | 1 | 1 | |
| 20 | 18 | 24 | 28 | 33 | 38 | 43 | 48 | 4 53 | 20 | 2 | 2 | 2 | 2 | 2 | |
| 30 | 9 | 14 | 19 | 23 | 28 | 33 | 38 | 43 | 30 | 2 | 3 | 3 | 3 | 3 | |
| 40 | 0 | 5 | 10 | 14 | 19 | 23 | 28 | 33 | 40 | 3 | 3 | 4 | 4 | 4 | |
| 50 | 3 51 | 3 56 | 0 | 5 | 9 | 13 | 18 | 22 | 50 | 4 | 4 | 4 | 5 | 5 | |
| 86 0 | 3 42 | 3 46 | 3 50 | 3 55 | 3 59 | 4 3 | 4 7 | 4 11 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 10 | 33 | 37 | 41 | 45 | 49 | 3 53 | 3 57 | 1 | 10 | 1 | 1 | 1 | 1 | 1 | |
| 20 | 23 | 27 | 31 | 35 | 39 | 43 | 46 | 3 50 | 20 | 1 | 1 | 2 | 2 | 2 | |
| 30 | 14 | 18 | 21 | 25 | 29 | 33 | 36 | 40 | 30 | 2 | 2 | 2 | 2 | 2 | |
| 40 | 5 | 9 | 12 | 16 | 19 | 23 | 26 | 30 | 40 | 3 | 3 | 3 | 3 | 3 | |
| 50 | 2 56 | 2 59 | 3 | 6 | 9 | 13 | 16 | 19 | 50 | 3 | 3 | 3 | 4 | 4 | |
| 87 0 | 2 47 | 2 50 | 2 53 | 2 56 | 2 59 | 3 2 | 3 5 | 3 9 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 37 | 40 | 43 | 46 | 49 | 2 52 | 2 55 | 2 58 | 10 | 0 | 1 | 1 | 1 | 1 | |
| 20 | 28 | 31 | 33 | 36 | 39 | 42 | 45 | 47 | 20 | 1 | 1 | 1 | 1 | 1 | |
| 30 | 19 | 21 | 24 | 26 | 29 | 32 | 34 | 37 | 30 | 1 | 1 | 2 | 2 | 2 | |
| 40 | 10 | 12 | 15 | 17 | 19 | 22 | 24 | 27 | 40 | 2 | 2 | 2 | 2 | 2 | |
| 50 | 1 | 3 | 5 | 7 | 9 | 12 | 14 | 16 | 50 | 2 | 2 | 2 | 3 | 3 | |
| 88 0 | 1 51 | 1 53 | 1 55 | 1 57 | 1 59 | 2 2 | 2 4 | 2 6 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 42 | 43 | 45 | 47 | 49 | 1 51 | 1 53 | 1 55 | 10 | 0 | 0 | 0 | 0 | 0 | |
| 20 | 32 | 34 | 36 | 38 | 39 | 41 | 43 | 44 | 20 | 1 | 1 | 1 | 1 | 1 | |
| 30 | 23 | 25 | 26 | 28 | 29 | 31 | 32 | 34 | 30 | 1 | 1 | 1 | 1 | 1 | |
| 40 | 14 | 15 | 16 | 19 | 20 | 21 | 22 | 24 | 40 | 1 | 1 | 1 | 1 | 1 | |
| 50 | 5 | 6 | 7 | 9 | 10 | 11 | 12 | 13 | 50 | 1 | 1 | 1 | 2 | 2 | |
| 89 0 | 0 56 | 0 57 | 0 58 | 0 59 | 1 0 | 1 1 | 1 2 | 1 3 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | 46 | 47 | 48 | 49 | 0 50 | 0 51 | 0 51 | 0 52 | 10 | 0 | 0 | 0 | 0 | 0 | |
| 20 | 37 | 37 | 38 | 39 | 40 | 40 | 41 | 42 | 20 | 0 | 0 | 0 | 0 | 0 | |
| 30 | 28 | 28 | 28 | 29 | 30 | 30 | 31 | 31 | 30 | 0 | 0 | 0 | 0 | 0 | |
| 40 | 19 | 19 | 19 | 19 | 20 | 20 | 21 | 21 | 40 | 0 | 0 | 0 | 0 | 0 | |
| 50 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 1 | 1 | 1 | 1 | 1 | |

TABLE 25. [Page 539

Table showing the variation of the altitude of an object arising from a change of 100 seconds in the declination. Unmarked quantities in the Table are positive. If the change move the body toward the elevated pole, apply the correction to the altitude with the signs in the Table; otherwise, change the signs.

| Declination | Altitude | Latitude of same name as declination. | | | | | | | | Latitude of different name from declination. | | | | | | | Altitude | Declination |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 70° | 60° | 50° | 40° | 30° | 20° | 10° | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | | |
| | 0 | 94 | 87 | 76 | 64 | 50 | 34 | 17 | 0 | 17 | 34 | 50 | 64 | 76 | 87 | 94 | 0 | |
| | 10 | 95 | 88 | 78 | 65 | 51 | 35 | 18 | 0 | 18 | 35 | 51 | 65 | 78 | 88 | 95 | 10 | |
| | 20 | 100 | 92 | 82 | 68 | 53 | 36 | 18 | 0 | 18 | 36 | 53 | 68 | 82 | 92 | 100 | 20 | |
| | 30 | | 100 | 88 | 74 | 57 | 39 | 20 | 0 | 20 | 39 | 57 | 74 | 88 | 100 | | 30 | |
| 0 | 40 | | | 100 | 84 | 65 | 45 | 22 | 0 | 22 | 45 | 65 | 84 | 100 | | | 40 | 0 |
| | 50 | | | | 100 | 78 | 53 | 27 | 0 | 27 | 53 | 78 | 100 | | | | 50 | |
| | 60 | | | | | 100 | 68 | 35 | 0 | 35 | 68 | 100 | | | | | 60 | |
| | 70 | | | | | | 100 | 51 | 0 | 51 | 100 | | | | | | 70 | |
| | 0 | 94 | 87 | 77 | 64 | 50 | 34 | 17 | 0 | 17 | 34 | 50 | 64 | 77 | 87 | 94 | 0 | |
| | 10 | 95 | 87 | 77 | 65 | 50 | 34 | 17 | −1 | 18 | 35 | 51 | 66 | 78 | 88 | 96 | 10 | |
| | 20 | 99 | 91 | 81 | 67 | 52 | 35 | 17 | −1 | 19 | 37 | 54 | 69 | 83. | 93 | 101 | 20 | |
| | 30 | 107 | 98 | 87 | 73 | 56 | 38 | 18 | −2 | 22 | 41 | 59 | 76 | 90 | 102 | | 30 | |
| 2 | 40 | | 111 | 98 | 82 | 63 | 42 | 20 | −2 | 25 | 47 | 68 | 86 | 102 | | | 40 | 2 |
| | 50 | | | 116 | 97 | 74 | 50 | 24 | −3 | 30 | 57 | 81 | 103 | | | | 50 | |
| | 60 | | | | 124 | 95 | 64 | 30 | −5 | 40 | 73 | 103 | | | | | 60 | |
| | 70 | | | | | 139 | 92 | 43 | −8 | 59 | 108 | | | | | | 70 | |
| | 0 | 94 | 87 | 77 | 64 | 50 | 34 | 17 | 0 | 17 | 34 | 50 | 64 | 77 | 87 | 94 | 0 | |
| | 10 | 94 | 87 | 77 | 64 | 50 | 34 | 16 | −1 | 19 | 36 | 52 | 67 | 79 | 89 | 97 | 10 | |
| | 20 | 98 | 90 | 79 | 66 | 51 | 34 | 16 | −3 | 21 | 39 | 56 | 71 | 84 | 95 | 103 | 20 | |
| | 30 | 105 | 96 | 85 | 70 | 54 | 36 | 16 | −4 | 24 | 44 | 62 | 78 | 93 | 104 | | 30 | |
| 4 | 40 | | 107 | 94 | 78 | 59 | 39 | 17 | −6 | 29 | .51 | 71 | 90 | 106 | | | 40 | 4 |
| | 50 | | | 111 | 92 | 70 | 45 | 19 | −8 | 35 | 62 | 86 | 109 | | | | 50 | |
| | 60 | | | | 117 | 88 | 56 | 23 | −12 | 47 | 81 | 112 | | | | | 60 | |
| | 70 | | | | | 127 | 81 | 32 | −19 | 70 | 119 | | | | | | 70 | |
| | 0 | 94 | 87 | 77 | 65 | 50 | 34 | 17 | 0 | 17 | 34 | 50 | 65 | 77 | 87 | 94 | 0 | |
| | 10 | 94 | 87 | 76 | 64 | 49 | 33 | 16 | −2 | 20 | 37 | 53 | 67 | 80 | 90 | 98 | 10 | |
| | 20 | 97 | 89 | 78 | 65 | 50 | 33 | 15 | −4 | 22 | 40 | 57 | 73 | 86 | 96 | 104 | 20 | |
| | 30 | 103 | 94 | 83 | 69 | 52 | 34 | 14 | −6 | 26 | 46 | 64 | 81 | 95 | 107 | | 30 | |
| 6 | 40 | | 105 | 92 | 76 | 57 | 36 | 14 | −9 | 32 | 54 | 74 | 93 | 109 | | | 40 | 6 |
| | 50 | | | 107 | 88 | 66 | 41 | 15 | −13 | 40 | 66 | 91 | 113 | | | | 50 | |
| | 60 | | | | 111 | 82 | 51 | 17 | −18 | 53 | 87 | 119 | | | | | 60 | |
| | 70 | | | | | 118 | 72 | 22 | −29 | 80 | 129 | | | | | | 70 | |
| | 0 | 95 | 87 | 77 | 65 | 50 | 35 | 18 | 0 | 18 | 35 | 50 | 65 | 77 | 87 | 95 | 0 | |
| | 10 | 94 | 86 | 76 | 63 | 49 | 33 | 15 | −3 | 20 | 38 | 54 | 68 | 81 | 91 | 99 | 10 | |
| | 20 | 96 | 88 | 77 | 64 | 49 | 32 | 14 | −5 | 24 | 40 | 59 | 74 | 87 | 98 | 106 | 20 | |
| | 30 | 101 | 93 | 81 | 67 | 50 | 32 | 12 | −8 | 28 | 48 | 66 | 83 | 97 | 109 | | 30 | |
| 8 | 40 | | 102 | 89 | 73 | 54 | 33 | 11 | −12 | 35 | 57 | 78 | 97 | 113 | | | 40 | 8 |
| | 50 | | | 104 | 84 | 62 | 37 | 11 | −17 | 44 | 70 | 95 | 118 | | | | 50 | |
| | 60 | | | | 105 | 77 | 45 | 11 | −24 | 59 | 93 | 125 | | | | | 60 | |
| | 70 | | | | | 109 | 62 | 13 | −39 | 90 | 140 | | | | | | 70 | |
| | 0 | 95 | 88 | 78 | 65 | 51 | 35 | 18 | 0 | 18 | 35 | 51 | 65 | 78 | 88 | 95 | 0 | |
| | 10 | 94 | 86 | 75 | 63 | 48 | 32 | 15 | −3 | 21 | 38 | 55 | 69 | 82 | 92 | 100 | 10 | |
| | 20 | 95 | 87 | 76 | 63 | 48 | 31 | 12 | −6 | 25 | 43 | 60 | 76 | 89 | 100 | | 20 | |
| | 30 | 100 | 91 | 80 | 65 | 49 | 30 | 10 | −10 | 30 | 50 | 69 | 86 | 100 | | | 30 | |
| 10 | 40 | | 100 | 87 | 70 | 51 | 31 | 8 | −15 | 38 | 60 | 81 | 100 | | | | 40 | 10 |
| | 50 | | | 100 | 81 | 58 | 33 | 6 | −21 | 48 | 75 | 100 | | | | | 50 | |
| | 60 | | | | 100 | 71 | 39 | 5 | −31 | 66 | 100 | | | | | | 60 | |
| | 70 | | | | | 100 | 53 | 3 | −48 | 100 | | | | | | | 70 | |
| | 0 | 96 | 89 | 78 | 66 | 51 | 35 | 18 | 0 | 18 | 35 | 51 | 66 | 78 | 89 | 96 | 0 | |
| | 10 | 94 | 86 | 76 | 63 | 48 | 32 | 14 | −4 | 22 | 39 | 56 | 70 | 83 | 94 | 101 | 10 | |
| | 20 | 94 | 86 | 76 | 62 | 47 | 29 | 11 | −8 | 27 | 45 | 62 | 78 | 91 | 102 | | 20 | |
| | 30 | 99 | 90 | 78 | 64 | 47 | 28 | 8 | −12 | 33 | 53 | 71 | 88 | 103 | | | 30 | |
| 12 | 40 | 108 | 98 | 84 | 68 | 49 | 28 | 5 | −18 | 41 | 63 | 85 | 104 | | | | 40 | 12 |
| | 50 | | 112 | 97 | 77 | 54 | 29 | 2 | −25 | 53 | 80 | 105 | | | | | 50 | |
| | 60 | | | 120 | 95 | 65 | 33 | −1 | −37 | 72 | 107 | | | | | | 60 | |
| | 70 | | | | 134 | 91 | 44 | −6 | −58 | 110 | | | | | | | 70 | |
| Declination | Altitude | 70° | 60° | 50° | 40° | 30° | 20° | 10° | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | Altitude | Declination |
| | | Latitude of same name as declination. | | | | | | | | Latitude of different name from declination. | | | | | | | | |

# TABLE 25.

Table showing the variation of the altitude of an object arising from a change of 100 seconds in the declination. Unmarked quantities in the Table are positive. If the change move the body toward the elevated pole, apply the correction to the altitude with the signs in the Table; otherwise, change the signs.

| Declination | Altitude | Latitude of same name as declination | | | | | | | 0° | Latitude of different name from declination | | | | | | | Altitude | Declination |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 70° | 60° | 50° | 40° | 30° | 20° | 10° | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | | |
| 14 | 0 | 97 | 89 | 79 | 66 | 52 | 35 | 18 | 0 | 18 | 35 | 52 | 66 | 79 | 89 | 97 | 0 | 14 |
| | 10 | 94 | 86 | 76 | 63 | 48 | 31 | 14 | -4 | 23 | 40 | 57 | 72 | 85 | 95 | 103 | 10 | |
| | 20 | 94 | 86 | 75 | 61 | 46 | 27 | 10 | -9 | 28 | 45 | 64 | 80 | 93 | 104 | | 20 | |
| | 30 | 97 | 89 | 77 | 62 | 45 | 26 | 6 | -14 | 35 | 55 | 74 | 91 | 106 | | | 30 | |
| | 40 | 106 | 96 | 82 | 66 | 46 | 25 | 2 | -21 | 44 | 67 | 88 | 107 | | | | 40 | |
| | 50 | | 109 | 93 | 73 | 50 | 25 | -2 | -30 | 58 | 85 | 110 | | | | | 50 | |
| | 60 | | | 115 | 89 | 60 | 27 | -7 | -43 | 79 | 114 | | | | | | 60 | |
| | 70 | | | | 125 | 82 | 35 | -16 | -69 | 121 | | | | | | | 70 | |
| 16 | 0 | 98 | 90 | 80 | 67 | 52 | 36 | 18 | 0 | 18 | 36 | 52 | 67 | 80 | 90 | 98 | 0 | 16 |
| | 10 | 94 | 86 | 76 | 63 | 48 | 31 | 13 | -5 | 23 | 41 | 58 | 73 | 86 | 97 | 104 | 10 | |
| | 20 | 94 | 85 | 74 | 61 | 45 | 27 | 9 | -10 | 30 | 48 | 66 | 82 | 95 | 106 | | 20 | |
| | 30 | 96 | 87 | 75 | 61 | 44 | 25 | 4 | -17 | 37 | 58 | 77 | 94 | 109 | | | 30 | |
| | 40 | 104 | 94 | 80 | 63 | 44 | 22 | 0 | -24 | 48 | 70 | 92 | 111 | | | | 40 | |
| | 50 | | 106 | 90 | 70 | 47 | 21 | -6 | -34 | 62 | 90 | 115 | | | | | 50 | |
| | 60 | | | 110 | 84 | 54 | 21 | -14 | -50 | 86 | 121 | | | | | | 60 | |
| | 70 | | | | 117 | 73 | 25 | -26 | -79 | 132 | | | | | | | 70 | |
| 18 | 0 | 99 | 91 | 81 | 68 | 53 | 36 | 18 | 0 | 18 | 36 | 53 | 68 | 81 | 91 | 99 | 0 | 18 |
| | 10 | 95 | 87 | 76 | 63 | 48 | 31 | 13 | -6 | 24 | 42 | 59 | 74 | 88 | 98 | 106 | 10 | |
| | 20 | 93 | 85 | 74 | 60 | 44 | 26 | 8 | -12 | 31 | 50 | 68 | 84 | 98 | 109 | | 20 | |
| | 30 | 95 | 86 | 74 | 59 | 42 | 23 | 2 | -19 | 40 | 60 | 79 | 97 | 112 | | | 30 | |
| | 40 | 102 | 92 | 78 | 61 | 41 | 20 | -3 | -27 | 51 | 74 | 96 | 116 | | | | 40 | |
| | 50 | | 103 | 87 | 66 | 43 | 17 | -10 | -39 | 67 | 95 | 121 | | | | | 50 | |
| | 60 | | | 105 | 79 | 49 | 16 | -20 | -56 | 93 | 128 | | | | | | 60 | |
| | 70 | | | | 108 | 64 | 16 | -36 | -89 | 143 | | | | | | | 70 | |
| 20 | 0 | 100 | 92 | 82 | 68 | 53 | 36 | 18 | 0 | 18 | 36 | 53 | 68 | 82 | 92 | 100 | 0 | 20 |
| | 10 | 95 | 87 | 76 | 63 | 48 | 31 | 12 | -6 | 25 | 43 | 60 | 76 | 89 | 100 | | 10 | |
| | 20 | 93 | 85 | 74 | 60 | 43 | 25 | 6 | -13 | 33 | 52 | 70 | 86 | 100 | | | 20 | |
| | 30 | 94 | 85 | 73 | 58 | 40 | 21 | 0 | -21 | 42 | 63 | 82 | 100 | | | | 30 | |
| | 40 | 100 | 90 | 76 | 59 | 39 | 17 | -6 | -31 | 55 | 78 | 100 | | | | | 40 | |
| | 50 | | 100 | 83 | 63 | 39 | 13 | -15 | -43 | 72 | 100 | | | | | | 50 | |
| | 60 | | | 100 | 74 | 43 | 10 | -26 | -63 | 100 | | | | | | | 60 | |
| | 70 | | | | 100 | 56 | 6 | -46 | -100 | | | | | | | | 70 | |
| 22 | 0 | | 93 | 83 | 69 | 54 | 37 | 19 | 0 | 19 | 37 | 54 | 69 | 83 | 93 | 101 | 0 | 22 |
| | 10 | 96 | 88 | 77 | 64 | 48 | 30 | 12 | -7 | 26 | 45 | 62 | 78 | 91 | 102 | | 10 | |
| | 20 | 93 | 85 | 73 | 59 | 43 | 25 | 5 | -15 | 35 | 54 | 72 | 88 | 103 | | | 20 | |
| | 30 | 94 | 85 | 72 | 57 | 39 | 19 | -2 | -23 | 45 | 66 | 86 | 103 | | | | 30 | |
| | 40 | 98 | 88 | 74 | 57 | 36 | 14 | -9 | -34 | 58 | 82 | 104 | | | | | 40 | |
| | 50 | 110 | 97 | 80 | 60 | 36 | 9 | -19 | -48 | 77 | 106 | | | | | | 50 | |
| | 60 | | 117 | 95 | 68 | 38 | 4 | -33 | -70 | 107 | | | | | | | 60 | |
| | 70 | | | 131 | 92 | 47 | -3 | -56 | -111 | | | | | | | | 70 | |
| 24 | 0 | | 95 | 84 | 70 | 55 | 37 | 19 | 0 | 19 | 37 | 55 | 70 | 84 | 95 | 103 | 0 | 24 |
| | 10 | 97 | 88 | 77 | 64 | 48 | 30 | 11 | -8 | 27 | 46 | 63 | 79 | 93 | 104 | | 10 | |
| | 20 | 93 | 85 | 73 | 59 | 42 | 24 | 4 | -16 | 36 | 56 | 74 | 91 | 105 | | | 20 | |
| | 30 | 93 | 84 | 71 | 56 | 38 | 18 | -4 | -26 | 48 | 69 | 89 | 107 | | | | 30 | |
| | 40 | 97 | 86 | 72 | 54 | 34 | 12 | -12 | -37 | 62 | 86 | 109 | | | | | 40 | |
| | 50 | 107 | 93 | 77 | 56 | 32 | 5 | -23 | -53 | 83 | 111 | | | | | | 50 | |
| | 60 | | 112 | 91 | 64 | 32 | -2 | -39 | -77 | 115 | | | | | | | 60 | |
| | 70 | | | 123 | 83 | 38 | -13 | -67 | -122 | | | | | | | | 70 | |
| 26 | 0 | | 96 | 85 | 72 | 56 | 38 | 19 | 0 | 19 | 38 | 56 | 72 | 85 | 96 | 105 | 0 | 26 |
| | 10 | 98 | 89 | 78 | 64 | 48 | 30 | 11 | -9 | 28 | 47 | 65 | 81 | 95 | 106 | | 10 | |
| | 20 | 95 | 85 | 73 | 59 | 41 | 23 | 3 | -18 | 38 | 56 | 77 | 94 | 108 | | | 20 | |
| | 30 | 93 | 83 | 70 | 54 | 36 | 16 | -6 | -28 | 50 | 72 | 92 | 111 | | | | 30 | |
| | 40 | 96 | 85 | 70 | 52 | 32 | 9 | -16 | -41 | 66 | 91 | 114 | | | | | 40 | |
| | 50 | 105 | 92 | 74 | 53 | 28 | 1 | -28 | -58 | 88 | 117 | | | | | | 50 | |
| | 60 | | 108 | 86 | 58 | 27 | -8 | -46 | -84 | 123 | | | | | | | 60 | |
| | 70 | | | 115 | 75 | 29 | -23 | -78 | -134 | | | | | | | | 70 | |
| Declination | Altitude | 70° | 60° | 50° | 40° | 30° | 20° | 10° | 0° | 10° | 20° | 30° | 40° | 50° | 60° | 70° | Altitude | Declination |
| | | Latitude of same name as declination | | | | | | | | Latitude of different name from declination | | | | | | | | |

TABLE 26.     [Page 541

Variation of Altitude in one minute from meridian passage.

| Lati-tude. | Declination of the same name as the latitude; upper transit; reduction additive. | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | |
| 0 | | | | | 28.1 | 22.4 | 18.7 | 16.0 | 14.0 | 12.4 | 11.1 | 10.1 | 0 |
| 1 | | | | | | 28.0 | 22.4 | 18.6 | 16.0 | 13.9 | 12.4 | 11.1 | 1 |
| 2 | | | | | | | 28.0 | 22.3 | 18.6 | 15.9 | 13.9 | 12.3 | 2 |
| 3 | | | | | | | | 27.9 | 22.3 | 18.5 | 15.8 | 13.8 | 3 |
| 4 | 28.1 | | | | | | | | 27.8 | 22.2 | 18.5 | 15.8 | 4 |
| 5 | 22.4 | 28.0 | 28.0 | | | | | | | 27.7 | 22.1 | 18.4 | 5 |
| 6 | 18.7 | 22.4 | 22.3 | | | | | | | | 27.6 | 22.0 | 6 |
| 7 | 16.0 | 18.6 | 22.3 | 27.9 | | | | | | | | 27.4 | 7 |
| 8 | 14.0 | 16.0 | 18.6 | 22.3 | 27.8 | | | | | | | | 8 |
| 9 | 12.4 | 13.9 | 15.9 | 18.5 | 22.2 | 27.7 | | | | | | | 9 |
| 10 | 11.1 | 12.4 | 13.9 | 15.8 | 18.5 | 22.1 | 27.6 | | | | | | 10 |
| 11 | 10.1 | 11.1 | 12.3 | 13.8 | 15.8 | 18.4 | 22.0 | 27.4 | | | | | 11 |
| 12 | 9.2 | 10.1 | 11.1 | 12.3 | 13.8 | 15.7 | 18.3 | 21.9 | 27.3 | | | | 12 |
| 13 | 8.5 | 9.2 | 10.0 | 11.0 | 12.2 | 13.7 | 15.6 | 18.2 | 21.7 | 27.1 | | | 13 |
| 14 | 7.9 | 8.5 | 9.2 | 10.0 | 10.9 | 12.1 | 13.6 | 15.5 | 18.0 | 21.6 | 26.9 | | 14 |
| 15 | 7.3 | 7.8 | 8.4 | 9.1 | 9.9 | 10.9 | 12.1 | 13.5 | 15.4 | 17.9 | 21.4 | 26.7 | 15 |
| 16 | 6.8 | 7.3 | 7.8 | 8.4 | 9.1 | 9.8 | 10.8 | 12.0 | 13.4 | 15.3 | 17.8 | 21.3 | 16 |
| 17 | 6.4 | 6.8 | 7.2 | 7.8 | 8.3 | 9.0 | 9.8 | 10.7 | 11.9 | 13.3 | 15.2 | 17.6 | 17 |
| 18 | 6.0 | 6.4 | 6.8 | 7.2 | 7.7 | 8.3 | 8.9 | 9.7 | 10.6 | 11.8 | 13.2 | 15.0 | 18 |
| 19 | 5.7 | 6.0 | 6.3 | 6.7 | 7.2 | 7.6 | 8.2 | 8.9 | 9.6 | 10.6 | 11.7 | 13.1 | 19 |
| 20 | 5.4 | 5.7 | 6.0 | 6.3 | 6.7 | 7.1 | 7.6 | 8.1 | 8.8 | 9.5 | 10.5 | 11.6 | 20 |
| 21 | 5.1 | 5.4 | 5.6 | 5.9 | 6.3 | 6.6 | 7.0 | 7.5 | 8.1 | 8.7 | 9.5 | 10.4 | 21 |
| 22 | 4.9 | 5.1 | 5.3 | 5.6 | 5.9 | 6.2 | 6.6 | 7.0 | 7.5 | 8.0 | 8.6 | 9.4 | 22 |
| 23 | 4.6 | 4.8 | 5.0 | 5.3 | 5.5 | 5.8 | 6.1 | 6.5 | 6.9 | 7.4 | 7.9 | 8.5 | 23 |
| 24 | 4.4 | 4.6 | 4.8 | 5.0 | 5.2 | 5.5 | 5.8 | 6.1 | 6.4 | 6.8 | 7.3 | 7.8 | 24 |
| 25 | 4.2 | 4.4 | 4.6 | 4.7 | 5.0 | 5.2 | 5.4 | 5.7 | 6.0 | 6.4 | 6.8 | 7.2 | 25 |
| 26 | 4.0 | 4.2 | 4.3 | 4.5 | 4.7 | 4.9 | 5.1 | 5.4 | 5.7 | 6.0 | 6.3 | 6.7 | 26 |
| 27 | 3.9 | 4.0 | 4.1 | 4.3 | 4.5 | 4.7 | 4.9 | 5.1 | 5.3 | 5.6 | 5.9 | 6.2 | 27 |
| 28 | 3.7 | 3.8 | 4.0 | 4.1 | 4.3 | 4.4 | 4.6 | 4.8 | 5.0 | 5.3 | 5.5 | 5.8 | 28 |
| 29 | 3.5 | 3.7 | 3.8 | 3.9 | 4.1 | 4.2 | 4.4 | 4.6 | 4.7 | 5.0 | 5.2 | 5.5 | 29 |
| 30 | 3.4 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 4.2 | 4.3 | 4.5 | 4.7 | 4.9 | 5.1 | 30 |
| 31 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.8 | 4.0 | 4.1 | 4.3 | 4.4 | 4.6 | 4.8 | 31 |
| 32 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.7 | 3.8 | 3.9 | 4.1 | 4.2 | 4.4 | 4.6 | 32 |
| 33 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 4.2 | 4.3 | 33 |
| 34 | 2.9 | 3.0 | 3.1 | 3.2 | 3.2 | 3.3 | 3.4 | 3.6 | 3.7 | 3.8 | 3.9 | 4.1 | 34 |
| 35 | 2.8 | 2.9 | 3.0 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.9 | 35 |
| 36 | 2.7 | 2.8 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 36 |
| 37 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 37 |
| 38 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.8 | 2.9 | 3.0 | 3.0 | 3.2 | 3.2 | 3.3 | 38 |
| 39 | 2.4 | 2.5 | 2.5 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 2.9 | 3.0 | 3.1 | 3.2 | 39 |
| 40 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 3.0 | 3.0 | 40 |
| 41 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.8 | 2.9 | 41 |
| 42 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 42 |
| 43 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.5 | 2.6 | 2.7 | 43 |
| 44 | 2.0 | 2.1 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.5 | 44 |
| 45 | 2.0 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 45 |
| 46 | 1.9 | 1.9 | 2.0 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.2 | 2.3 | 2.3 | 46 |
| 47 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 2.0 | 2.1 | 2.1 | 2.1 | 2.2 | 2.2 | 47 |
| 48 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 2.0 | 2.1 | 2.1 | 2.1 | 48 |
| 49 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 49 |
| 50 | 1.6 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 50 |
| 51 | 1.6 | 1.6 | 1.6 | 1.7 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 51 |
| 52 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 52 |
| 53 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 1.7 | 1.7 | 1.7 | 53 |
| 54 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 54 |
| 55 | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 55 |
| 56 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 56 |
| 57 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 57 |
| 58 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 58 |
| 59 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 59 |
| 60 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 60 |
| | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | |

Declination of the same name as the latitude; upper transit; reduction additive.

# TABLE 26.

### Variation of Altitude in one minute from meridian passage.

| Lati-tude. | Declination of the same name as the latitude; upper transit; reduction additive. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 24° | |
| ° | *''* | *''* | *''* | *''* | *''* | *''* | *''* | *''* | *''* | *''* | *''* | *''* | *''* | ° |
| 0 | 9.2 | 8.5 | 7.9 | 7.3 | 6.8 | 6.4 | 6.0 | 5.7 | 5.4 | 5.1 | 4.9 | 4.6 | 4.4 | 0 |
| 1 | 10.1 | 9.2 | 8.5 | 7.8 | 7.3 | 6.8 | 6.4 | 6.0 | 5.7 | 5.4 | 5.1 | 4.8 | 4.6 | 1 |
| 2 | 11.1 | 10.0 | 9.2 | 8.4 | 7.8 | 7.2 | 6.8 | 6.3 | 6.0 | 5.6 | 5.3 | 5.0 | 4.8 | 2 |
| 3 | 12.3 | 11.0 | 10.0 | 9.1 | 8.4 | 7.8 | 7.2 | 6.7 | 6.3 | 5.9 | 5.6 | 5.3 | 5.0 | 3 |
| 4 | 13.8 | 12.2 | 10.9 | 9.9 | 9.1 | 8.3 | 7.7 | 7.2 | 6.7 | 6.3 | 5.9 | 5.5 | 5.2 | 4 |
| 5 | 15.7 | 13.7 | 12.1 | 10.9 | 9.8 | 9.0 | 8.3 | 7.6 | 7.1 | 6.6 | 6.2 | 5.8 | 5.5 | 5 |
| 6 | 18.3 | 15.6 | 13.6 | 12.1 | 10.8 | 9.8 | 8.9 | 8.2 | 7.6 | 7.0 | 6.6 | 6.1 | 5.8 | 6 |
| 7 | 21.9 | 18.2 | 15.5 | 13.5 | 12.0 | 10.7 | 9.7 | 8.9 | 8.1 | 7.5 | 7.0 | 6.5 | 6.1 | 7 |
| 8 | 27.3 | 21.7 | 18.0 | 15.4 | 13.4 | 11.9 | 10.6 | 9.6 | 8.8 | 8.1 | 7.5 | 6.9 | 6.4 | 8 |
| 9 | | 27.1 | 21.6 | 17.9 | 15.3 | 13.3 | 11.8 | 10.6 | 9.5 | 8.7 | 8.0 | 7.4 | 6.8 | 9 |
| 10 | | | 26.9 | 21.4 | 17.8 | 15.2 | 13.2 | 11.7 | 10.5 | 9.5 | 8.6 | 7.9 | 7.3 | 10 |
| 11 | | | | 26.7 | 21.3 | 17.6 | 15.0 | 13.1 | 11.6 | 10.4 | 9.4 | 8.5 | 7.8 | 11 |
| 12 | | | | | 26.5 | 21.1 | 17.5 | 14.9 | 13.0 | 11.5 | 10.3 | 9.3 | 8.4 | 12 |
| 13 | | | | | | 26.2 | 20.9 | 17.3 | 14.8 | 12.8 | 11.3 | 10.1 | 9.2 | 13 |
| 14 | | | | | | | 26.0 | 20.7 | 17.1 | 14.6 | 12.7 | 11.2 | 10.0 | 14 |
| 15 | | | | | | | | 25.7 | 20.4 | 16.9 | 14.4 | 12.5 | 11.1 | 15 |
| 16 | 26.5 | | | | | | | | 25.4 | 20.2 | 16.7 | 14.3 | 12.4 | 16 |
| 17 | 21.1 | 26.2 | | | | | | | | 25.1 | 20.0 | 16.5 | 14.1 | 17 |
| 18 | 17.5 | 20.9 | 26.0 | | | | | | | | 24.8 | 19.7 | 16.3 | 18 |
| 19 | 14.9 | 17.3 | 20.7 | 25.7 | | | | | | | | 24.5 | 19.5 | 19 |
| 20 | 13.0 | 14.8 | 17.1 | 20.4 | 25.4 | | | | | | | | 24.2 | 20 |
| 21 | 11.5 | 12.8 | 14.6 | 16.9 | 20.2 | 25.1 | | | | | | | | 21 |
| 22 | 10.3 | 11.3 | 12.7 | 14.4 | 16.7 | 20.0 | 24.8 | | | | | | | 22 |
| 23 | 9.3 | 10.1 | 11.2 | 12.5 | 14.3 | 16.5 | 19.7 | 24.5 | | | | | | 23 |
| 24 | 8.4 | 9.2 | 10.0 | 11.1 | 12.4 | 14.1 | 16.3 | 19.5 | 24.2 | | | | | 24 |
| 25 | 7.7 | 8.3 | 9.0 | 9.9 | 10.9 | 12.2 | 13.9 | 16.1 | 19.2 | 23.8 | | | | 25 |
| 26 | 7.1 | 7.6 | 8.2 | 8.9 | 9.8 | 10.8 | 12.1 | 13.7 | 15.9 | 18.9 | 23.5 | | | 26 |
| 27 | 6.6 | 7.0 | 7.5 | 8.1 | 8.8 | 9.6 | 10.6 | 11.9 | 13.5 | 15.6 | 18.6 | 23.1 | | 27 |
| 28 | 6.2 | 6.5 | 7.0 | 7.4 | 8.0 | 8.7 | 9.5 | 10.5 | 11.7 | 13.3 | 15.4 | 18.3 | 22.7 | 28 |
| 29 | 5.7 | 6.1 | 6.4 | 6.9 | 7.3 | 7.9 | 8.6 | 9.4 | 10.3 | 11.5 | 13.1 | 15.1 | 18.0 | 29 |
| 30 | 5.4 | 5.7 | 6.0 | 6.4 | 6.8 | 7.2 | 7.8 | 8.4 | 9.2 | 10.1 | 11.3 | 12.8 | 14.9 | 30 |
| 31 | 5.1 | 5.3 | 5.6 | 5.9 | 6.3 | 6.7 | 7.1 | 7.7 | 8.3 | 9.0 | 10.0 | 11.1 | 12.6 | 31 |
| 32 | 4.8 | 5.0 | 5.2 | 5.5 | 5.8 | 6.2 | 6.5 | 7.0 | 7.5 | 8.1 | 8.9 | 9.8 | 10.9 | 32 |
| 33 | 4.5 | 4.7 | 4.9 | 5.1 | 5.4 | 5.7 | 6.1 | 6.4 | 6.9 | 7.4 | 8.0 | 8.7 | 9.6 | 33 |
| 34 | 4.3 | 4.4 | 4.6 | 4.8 | 5.1 | 5.3 | 5.6 | 5.9 | 6.3 | 6.8 | 7.3 | 7.8 | 8.6 | 34 |
| 35 | 4.0 | 4.2 | 4.4 | 4.5 | 4.7 | 5.0 | 5.2 | 5.5 | 5.8 | 6.2 | 6.6 | 7.1 | 7.7 | 35 |
| 36 | 3.8 | 4.0 | 4.1 | 4.3 | 4.5 | 4.7 | 4.9 | 5.1 | 5.4 | 5.7 | 6.1 | 6.5 | 7.0 | 36 |
| 37 | 3.6 | 3.8 | 3.9 | 4.0 | 4.2 | 4.4 | 4.6 | 4.8 | 5.0 | 5.3 | 5.6 | 6.0 | 6.4 | 37 |
| 38 | 3.4 | 3.6 | 3.7 | 3.8 | 4.0 | 4.1 | 4.3 | 4.5 | 4.7 | 4.9 | 5.2 | 5.5 | 5.8 | 38 |
| 39 | 3.3 | 3.4 | 3.5 | 3.6 | 3.8 | 3.9 | 4.0 | 4.2 | 4.4 | 4.6 | 4.8 | 5.1 | 5.4 | 39 |
| 40 | 3.1 | 3.2 | 3.3 | 3.4 | 3.6 | 3.7 | 3.8 | 4.0 | 4.1 | 4.3 | 4.5 | 4.7 | 5.0 | 40 |
| 41 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 4.2 | 4.4 | 4.6 | 41 |
| 42 | 2.9 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.7 | 3.8 | 4.0 | 4.1 | 4.3 | 42 |
| 43 | 2.7 | 2.8 | 2.9 | 3.0 | 3.0 | 3.1 | 3.2 | 3.3 | 3.5 | 3.6 | 3.7 | 3.9 | 4.0 | 43 |
| 44 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.8 | 44 |
| 45 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 45 |
| 46 | 2.4 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 46 |
| 47 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.9 | 2.9 | 3.0 | 3.1 | 47 |
| 48 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 48 |
| 49 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 49 |
| 50 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.6 | 50 |
| 51 | 1.9 | 2.0 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 51 |
| 52 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.4 | 52 |
| 53 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 53 |
| 54 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 54 |
| 55 | 1.6 | 1.6 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 55 |
| 56 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 56 |
| 57 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 57 |
| 58 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 1.7 | 58 |
| 59 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 59 |
| 60 | 1.3 | 1.3 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 60 |
| | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 24° | |

### Declination of the same name as the latitude; upper transit; reduction additive.

# TABLE 26.

Variation of Altitude in one minute from meridian passage.

Declination of the **same** name as the latitude; **upper transit; reduction additive.**

| Latitude | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | Latitude |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |  |
| 0 | 4.2 | 4.0 | 3.9 | 3.7 | 3.5 | 3.4 | 3.3 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 0 |
| 1 | 4.4 | 4.2 | 4.0 | 3.8 | 3.7 | 3.5 | 3.4 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 1 |
| 2 | 4.6 | 4.3 | 4.1 | 4.0 | 3.8 | 3.6 | 3.5 | 3.3 | 3.2 | 3.1 | 3.0 | 2.8 | 2.7 | 2 |
| 3 | 4.7 | 4.5 | 4.3 | 4.1 | 3.9 | 3.7 | 3.6 | 3.4 | 3.3 | 3.2 | 3.0 | 2.9 | 2.8 | 3 |
| 4 | 5.0 | 4.7 | 4.5 | 4.3 | 4.1 | 3.9 | 3.7 | 3.5 | 3.4 | 3.3 | 3.1 | 3.0 | 2.9 | 4 |
| 5 | 5.2 | 4.9 | 4.7 | 4.4 | 4.2 | 4.0 | 3.8 | 3.7 | 3.5 | 3.3 | 3.2 | 3.1 | 3.0 | 5 |
| 6 | 5.4 | 5.1 | 4.9 | 4.6 | 4.4 | 4.2 | 4.0 | 3.8 | 3.6 | 3.5 | 3.3 | 3.2 | 3.0 | 6 |
| 7 | 5.7 | 5.4 | 5.1 | 4.8 | 4.6 | 4.3 | 4.1 | 3.9 | 3.7 | 3.6 | 3.4 | 3.3 | 3.1 | 7 |
| 8 | 6.0 | 5.7 | 5.3 | 5.0 | 4.8 | 4.5 | 4.3 | 4.1 | 3.9 | 3.7 | 3.5 | 3.4 | 3.2 | 8 |
| 9 | 6.4 | 6.0 | 5.6 | 5.3 | 5.0 | 4.7 | 4.4 | 4.2 | 4.0 | 3.8 | 3.6 | 3.5 | 3.3 | 9 |
| 10 | 6.8 | 6.3 | 5.9 | 5.5 | 5.2 | 4.9 | 4.6 | 4.4 | 4.2 | 3.9 | 3.8 | 3.6 | 3.4 | 10 |
| 11 | 7.2 | 6.7 | 6.2 | 5.8 | 5.5 | 5.1 | 4.8 | 4.6 | 4.3 | 4.1 | 3.9 | 3.7 | 3.5 | 11 |
| 12 | 7.7 | 7.1 | 6.6 | 6.2 | 5.8 | 5.4 | 5.1 | 4.8 | 4.5 | 4.3 | 4.0 | 3.8 | 3.6 | 12 |
| 13 | 8.3 | 7.6 | 7.1 | 6.5 | 6.1 | 5.7 | 5.3 | 5.0 | 4.7 | 4.4 | 4.2 | 4.0 | 3.8 | 13 |
| 14 | 9.1 | 8.2 | 7.6 | 7.0 | 6.4 | 6.0 | 5.6 | 5.2 | 4.9 | 4.6 | 4.4 | 4.1 | 3.9 | 14 |
| 15 | 9.9 | 8.9 | 8.1 | 7.4 | 6.9 | 6.4 | 5.9 | 5.5 | 5.2 | 4.8 | 4.5 | 4.3 | 4.0 | 15 |
| 16 | 10.9 | 9.8 | 8.8 | 8.0 | 7.3 | 6.8 | 6.3 | 5.8 | 5.4 | 5.1 | 4.8 | 4.5 | 4.2 | 16 |
| 17 | 12.2 | 10.8 | 9.6 | 8.7 | 7.9 | 7.2 | 6.7 | 6.2 | 5.7 | 5.3 | 5.0 | 4.7 | 4.4 | 17 |
| 18 | 13.9 | 12.1 | 10.6 | 9.5 | 8.6 | 7.8 | 7.1 | 6.6 | 6.1 | 5.6 | 5.2 | 4.9 | 4.6 | 18 |
| 19 | 16.1 | 13.7 | 11.9 | 10.5 | 9.4 | 8.4 | 7.7 | 7.0 | 6.4 | 6.0 | 5.5 | 5.1 | 4.8 | 19 |
| 20 | 19.2 | 15.9 | 13.5 | 11.7 | 10.3 | 9.2 | 8.3 | 7.5 | 6.9 | 6.3 | 5.8 | 5.4 | 5.0 | 20 |
| 21 | 23.8 | 18.9 | 15.6 | 13.3 | 11.5 | 10.2 | 9.1 | 8.2 | 7.4 | 6.8 | 6.2 | 5.7 | 5.3 | 21 |
| 22 |  | 23.5 | 18.6 | 15.4 | 13.1 | 11.3 | 10.0 | 8.9 | 8.0 | 7.3 | 6.6 | 6.1 | 5.6 | 22 |
| 23 |  |  | 23.1 | 18.3 | 15.1 | 12.8 | 11.1 | 9.8 | 8.7 | 7.9 | 7.1 | 6.5 | 6.0 | 23 |
| 24 |  |  |  | 22.7 | 18.0 | 14.9 | 12.6 | 10.9 | 9.6 | 8.6 | 7.7 | 7.0 | 6.4 | 24 |
| 25 |  |  |  |  | 22.3 | 17.7 | 14.6 | 12.4 | 10.7 | 9.4 | 8.4 | 7.5 | 6.8 | 25 |
| 26 |  |  |  |  |  | 21.9 | 17.4 | 14.3 | 12.1 | 10.5 | 9.2 | 8.2 | 7.4 | 26 |
| 27 |  |  |  |  |  |  | 21.5 | 17.0 | 14.0 | 11.9 | 10.3 | 9.1 | 8.1 | 27 |
| 28 |  |  |  |  |  |  |  | 21.1 | 16.7 | 13.8 | 11.7 | 10.1 | 8.9 | 28 |
| 29 | 22.3 |  |  |  |  |  |  |  | 20.6 | 16.3 | 13.5 | 11.4 | 9.9 | 29 |
| 30 | 17.7 | 21.9 |  |  |  |  |  |  |  | 20.2 | 16.0 | 13.2 | 11.1 | 30 |
| 31 | 14.6 | 17.4 | 21.5 |  |  |  |  |  |  |  | 19.8 | 15.6 | 12.9 | 31 |
| 32 | 12.4 | 14.3 | 17.0 | 21.1 |  |  |  |  |  |  |  | 19.3 | 15.3 | 32 |
| 33 | 10.7 | 12.1 | 14.0 | 16.7 | 20.6 |  |  |  |  |  |  |  | 18.9 | 33 |
| 34 | 9.4 | 10.5 | 11.9 | 13.8 | 16.3 | 20.2 |  |  |  |  |  |  |  | 34 |
| 35 | 8.4 | 9.2 | 10.3 | 11.7 | 13.5 | 16.0 | 19.8 |  |  |  |  |  |  | 35 |
| 36 | 7.5 | 8.2 | 9.1 | 10.1 | 11.4 | 13.2 | 15.6 | 19.3 |  |  |  |  |  | 36 |
| 37 | 6.8 | 7.4 | 8.1 | 8.9 | 9.9 | 11.1 | 12.9 | 15.3 | 18.9 |  |  |  |  | 37 |
| 38 | 6.2 | 6.7 | 7.2 | 7.9 | 8.7 | 9.6 | 10.9 | 12.6 | 14.9 | 18.4 |  |  |  | 38 |
| 39 | 5.7 | 6.1 | 6.5 | 7.1 | 7.7 | 8.5 | 9.4 | 10.6 | 12.2 | 14.5 | 17.9 |  |  | 39 |
| 40 | 5.3 | 5.6 | 6.0 | 6.4 | 6.9 | 7.5 | 8.2 | 9.2 | 10.4 | 11.9 | 14.1 | 17.4 |  | 40 |
| 41 | 4.9 | 5.2 | 5.5 | 5.8 | 6.2 | 6.7 | 7.3 | 8.0 | 8.9 | 10.1 | 11.6 | 13.8 | 17.0 | 41 |
| 42 | 4.5 | 4.8 | 5.0 | 5.3 | 5.7 | 6.1 | 6.6 | 7.1 | 7.8 | 8.7 | 9.8 | 11.3 | 13.4 | 42 |
| 43 | 4.2 | 4.4 | 4.6 | 4.9 | 5.2 | 5.5 | 5.9 | 6.4 | 6.9 | 7.6 | 8.5 | 9.5 | 11.0 | 43 |
| 44 | 3.9 | 4.1 | 4.3 | 4.5 | 4.8 | 5.1 | 5.4 | 5.8 | 6.2 | 6.7 | 7.4 | 8.2 | 9.3 | 44 |
| 45 | 3.7 | 3.8 | 4.0 | 4.2 | 4.4 | 4.7 | 4.9 | 5.2 | 5.6 | 6.0 | 6.6 | 7.2 | 8.0 | 45 |
| 46 | 3.5 | 3.6 | 3.7 | 3.9 | 4.1 | 4.3 | 4.5 | 4.8 | 5.1 | 5.4 | 5.9 | 6.4 | 7.0 | 46 |
| 47 | 3.3 | 3.4 | 3.5 | 3.6 | 3.8 | 4.0 | 4.2 | 4.4 | 4.6 | 4.9 | 5.3 | 5.7 | 6.2 | 47 |
| 48 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.7 | 3.9 | 4.0 | 4.3 | 4.5 | 4.8 | 5.1 | 5.5 | 48 |
| 49 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.6 | 3.7 | 3.9 | 4.1 | 4.4 | 4.6 | 5.0 | 49 |
| 50 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.5 | 3.6 | 3.8 | 4.0 | 4.2 | 4.5 | 50 |
| 51 | 2.6 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.4 | 3.5 | 3.7 | 3.9 | 4.1 | 51 |
| 52 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.4 | 3.6 | 3.7 | 52 |
| 53 | 2.3 | 2.3 | 2.4 | 2.5 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.3 | 3.4 | 53 |
| 54 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.5 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.2 | 54 |
| 55 | 2.0 | 2.1 | 2.1 | 2.2 | 2.3 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 55 |
| 56 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 | 2.3 | 2.4 | 2.4 | 2.5 | 2.6 | 2.7 | 56 |
| 57 | 1.8 | 1.9 | 1.9 | 2.0 | 2.0 | 2.0 | 2.1 | 2.2 | 2.2 | 2.3 | 2.3 | 2.4 | 2.5 | 57 |
| 58 | 1.7 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.3 | 2.3 | 58 |
| 59 | 1.6 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 2.2 | 59 |
| 60 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 1.9 | 2.0 | 2.0 | 60 |
|  | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° |  |

Declination of the same name as the latitude; **upper transit; reduction additive.**

# TABLE 26.

Variation of Altitude in one minute from meridian passage.

| Lati-tude. | Declination of the same name as the latitude; upper transit; reduction additive. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | 50° | |
| ° | " | " | " | " | " | " | " | " | " | " | " | " | " | ° |
| 0 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 0 |
| 1 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.7 | 1.7 | 1 |
| 2 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 2 |
| 3 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.7 | 3 |
| 4 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 4 |
| 5 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 5 |
| 6 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 6 |
| 7 | 3.0 | 2.9 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 7 |
| 8 | 3.1 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 1.9 | 1.9 | 8 |
| 9 | 3.2 | 3.0 | 2.9 | 2.8 | 2.7 | 2.5 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 1.9 | 9 |
| 10 | 3.3 | 3.1 | 3.0 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 1.9 | 10 |
| 11 | 3.4 | 3.2 | 3.1 | 2.9 | 2.8 | 2.7 | 2.6 | 2.4 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 11 |
| 12 | 3.5 | 3.3 | 3.1 | 3.0 | 2.9 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 12 |
| 13 | 3.6 | 3.4 | 3.2 | 3.1 | 2.9 | 2.8 | 2.7 | 2.6 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 13 |
| 14 | 3.7 | 3.5 | 3.3 | 3.2 | 3.0 | 2.9 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 14 |
| 15 | 3.8 | 3.6 | 3.4 | 3.3 | 3.1 | 3.0 | 2.8 | 2.7 | 2.6 | 2.4 | 2.3 | 2.2 | 2.1 | 15 |
| 16 | 4.0 | 3.8 | 3.6 | 3.4 | 3.2 | 3.0 | 2.9 | 2.8 | 2.6 | 2.5 | 2.4 | 2.3 | 2.2 | 16 |
| 17 | 4.1 | 3.9 | 3.7 | 3.5 | 3.3 | 3.1 | 3.0 | 2.8 | 2.7 | 2.6 | 2.4 | 2.3 | 2.2 | 17 |
| 18 | 4.3 | 4.1 | 3.8 | 3.6 | 3.4 | 3.2 | 3.1 | 2.9 | 2.8 | 2.6 | 2.5 | 2.4 | 2.3 | 18 |
| 19 | 4.5 | 4.2 | 4.0 | 3.7 | 3.5 | 3.3 | 3.2 | 3.0 | 2.8 | 2.7 | 2.6 | 2.4 | 2.3 | 19 |
| 20 | 4.7 | 4.4 | 4.1 | 3.9 | 3.7 | 3.5 | 3.3 | 3.1 | 2.9 | 2.8 | 2.6 | 2.5 | 2.4 | 20 |
| 21 | 4.9 | 4.6 | 4.3 | 4.0 | 3.8 | 3.6 | 3.4 | 3.2 | 3.0 | 2.9 | 2.7 | 2.6 | 2.4 | 21 |
| 22 | 5.2 | 4.8 | 4.5 | 4.2 | 4.0 | 3.7 | 3.5 | 3.3 | 3.1 | 2.9 | 2.8 | 2.6 | 2.5 | 22 |
| 23 | 5.5 | 5.1 | 4.7 | 4.4 | 4.1 | 3.9 | 3.6 | 3.4 | 3.2 | 3.0 | 2.9 | 2.7 | 2.6 | 23 |
| 24 | 5.8 | 5.4 | 5.0 | 4.6 | 4.3 | 4.0 | 3.8 | 3.5 | 3.3 | 3.1 | 3.0 | 2.8 | 2.6 | 24 |
| 25 | 6.2 | 5.7 | 5.3 | 4.9 | 4.5 | 4.2 | 3.9 | 3.7 | 3.5 | 3.3 | 3.1 | 2.9 | 2.7 | 25 |
| 26 | 6.7 | 6.1 | 5.6 | 5.2 | 4.8 | 4.4 | 4.1 | 3.8 | 3.6 | 3.4 | 3.2 | 3.0 | 2.8 | 26 |
| 27 | 7.2 | 6.5 | 6.0 | 5.5 | 5.0 | 4.6 | 4.3 | 4.0 | 3.7 | 3.5 | 3.3 | 3.1 | 2.9 | 27 |
| 28 | 7.9 | 7.1 | 6.4 | 5.8 | 5.3 | 4.9 | 4.5 | 4.2 | 3.9 | 3.6 | 3.4 | 3.2 | 3.0 | 28 |
| 29 | 8.7 | 7.7 | 6.9 | 6.2 | 5.7 | 5.2 | 4.8 | 4.4 | 4.1 | 3.8 | 3.5 | 3.3 | 3.1 | 29 |
| 30 | 9.6 | 8.5 | 7.5 | 6.7 | 6.1 | 5.5 | 5.1 | 4.7 | 4.3 | 4.0 | 3.7 | 3.4 | 3.2 | 30 |
| 31 | 10.9 | 9.4 | 8.2 | 7.3 | 6.6 | 5.9 | 5.4 | 4.9 | 4.5 | 4.2 | 3.9 | 3.6 | 3.3 | 31 |
| 32 | 12.6 | 10.6 | 9.2 | 8.0 | 7.1 | 6.4 | 5.8 | 5.2 | 4.8 | 4.4 | 4.0 | 3.7 | 3.5 | 32 |
| 33 | 14.9 | 12.2 | 10.4 | 8.9 | 7.8 | 6.9 | 6.2 | 5.6 | 5.1 | 4.6 | 4.3 | 3.9 | 3.6 | 33 |
| 34 | 18.4 | 14.5 | 11.9 | 10.1 | 8.7 | 7.6 | 6.7 | 6.0 | 5.4 | 4.9 | 4.5 | 4.1 | 3.8 | 34 |
| 35 | | 17.9 | 14.1 | 11.6 | 9.8 | 8.5 | 7.4 | 6.6 | 5.9 | 5.3 | 4.8 | 4.4 | 4.0 | 35 |
| 36 | | | 17.4 | 13.8 | 11.3 | 9.5 | 8.2 | 7.2 | 6.4 | 5.7 | 5.1 | 4.6 | 4.2 | 36 |
| 37 | | | | 17.0 | 13.4 | 11.0 | 9.3 | 8.0 | 7.0 | 6.2 | 5.5 | 5.0 | 4.5 | 37 |
| 38 | | | | | 16.5 | 13.0 | 10.7 | 9.0 | 7.7 | 6.8 | 6.0 | 5.3 | 4.8 | 38 |
| 39 | | | | | | 16.0 | 12.6 | 10.3 | 8.7 | 7.5 | 6.5 | 5.8 | 5.1 | 39 |
| 40 | | | | | | | 15.5 | 12.2 | 10.0 | 8.4 | 7.2 | 6.3 | 5.6 | 40 |
| 41 | | | | | | | | 15.0 | 11.8 | 9.7 | 8.1 | 7.0 | 6.1 | 41 |
| 42 | 16.5 | | | | | | | | 14.5 | 11.4 | 9.3 | 7.9 | 6.7 | 42 |
| 43 | 13.0 | 16.0 | | | | | | | | 14.0 | 11.0 | 9.0 | 7.6 | 43 |
| 44 | 10.7 | 12.6 | 15.5 | | | | | | | | 13.6 | 10.6 | 8.7 | 44 |
| 45 | 9.0 | 10.3 | 12.2 | 15.0 | | | | | | | | 13.1 | 10.2 | 45 |
| 46 | 7.7 | 8.7 | 10.0 | 11.8 | 14.5 | | | | | | | | 12.6 | 46 |
| 47 | 6.8 | 7.5 | 8.4 | 9.7 | 11.4 | 14.0 | | | | | | | | 47 |
| 48 | 6.0 | 6.5 | 7.2 | 8.1 | 9.3 | 11.0 | 13.6 | | | | | | | 48 |
| 49 | 5.3 | 5.8 | 6.3 | 7.0 | 7.9 | 9.0 | 10.6 | 13.1 | | | | | | 49 |
| 50 | 4.8 | 5.1 | 5.6 | 6.1 | 6.7 | 7.6 | 8.7 | 10.2 | 12.6 | | | | | 50 |
| 51 | 4.3 | 4.6 | 5.0 | 5.4 | 5.9 | 6.5 | 7.3 | 8.4 | 9.9 | 12.1 | | | | 51 |
| 52 | 3.9 | 4.2 | 4.5 | 4.8 | 5.2 | 5.7 | 6.3 | 7.0 | 8.0 | 9.5 | 11.6 | | | 52 |
| 53 | 3.6 | 3.8 | 4.0 | 4.3 | 4.6 | 5.0 | 5.4 | 6.0 | 6.7 | 7.7 | 9.1 | 11.1 | | 53 |
| 54 | 3.3 | 3.5 | 3.7 | 3.9 | 4.1 | 4.4 | 4.8 | 5.2 | 5.8 | 6.5 | 7.4 | 8.7 | 10.6 | 54 |
| 55 | 3.0 | 3.2 | 3.3 | 3.5 | 3.7 | 4.0 | 4.3 | 4.6 | 5.0 | 5.5 | 6.2 | 7.1 | 8.3 | 55 |
| 56 | 2.8 | 2.9 | 3.1 | 3.2 | 3.4 | 3.6 | 3.8 | 4.1 | 4.4 | 4.8 | 5.3 | 5.9 | 6.8 | 56 |
| 57 | 2.6 | 2.7 | 2.8 | 2.9 | 3.1 | 3.2 | 3.4 | 3.6 | 3.9 | 4.2 | 4.6 | 5.0 | 5.6 | 57 |
| 58 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.1 | 3.3 | 3.5 | 3.7 | 4.0 | 4.4 | 4.8 | 58 |
| 59 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 3.0 | 3.1 | 3.3 | 3.6 | 3.8 | 4.2 | 59 |
| 60 | 2.1 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 60 |
| | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | 50° | |

Declination of the same name as the latitude; upper transit; reduction additive.

# TABLE 26.

## Variation of Altitude in one minute from meridian passage.

Declination of the same name as the latitude; upper transit; reduction additive.

| Latitude. | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | 61° | 62° | 63° | Latitude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 0 |
| 1 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1 |
| 2 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 2 |
| 3 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 3 |
| 4 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 4 |
| 5 | 1.7 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.1 | 1.1 | 1.1 | 5 |
| 6 | 1.7 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 6 |
| 7 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 7 |
| 8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 8 |
| 9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.1 | 1.1 | 9 |
| 10 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 10 |
| 11 | 1.9 | 1.8 | 1.7 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 11 |
| 12 | 1.9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.2 | 1.2 | 1.1 | 12 |
| 13 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.1 | 13 |
| 14 | 2.0 | 1.9 | 1.8 | 1.7 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 14 |
| 15 | 2.0 | 1.9 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 15 |
| 16 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.2 | 1.2 | 16 |
| 17 | 2.1 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 17 |
| 18 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 18 |
| 19 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.2 | 19 |
| 20 | 2.3 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.2 | 20 |
| 21 | 2.3 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.2 | 21 |
| 22 | 2.4 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.3 | 1.3 | 22 |
| 23 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.4 | 1.3 | 23 |
| 24 | 2.5 | 2.4 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 24 |
| 25 | 2.6 | 2.4 | 2.3 | 2.2 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.4 | 1.3 | 25 |
| 26 | 2.6 | 2.5 | 2.3 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 | 26 |
| 27 | 2.7 | 2.6 | 2.4 | 2.3 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.4 | 27 |
| 28 | 2.8 | 2.6 | 2.5 | 2.3 | 2.2 | 2.1 | 2.0 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 28 |
| 29 | 2.9 | 2.7 | 2.5 | 2.4 | 2.3 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 29 |
| 30 | 3.0 | 2.8 | 2.6 | 2.5 | 2.3 | 2.2 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 30 |
| 31 | 3.1 | 2.9 | 2.7 | 2.5 | 2.4 | 2.2 | 2.1 | 2.0 | 1.9 | 1.7 | 1.6 | 1.5 | 1.4 | 31 |
| 32 | 3.2 | 3.0 | 2.8 | 2.6 | 2.4 | 2.3 | 2.2 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 32 |
| 33 | 3.4 | 3.1 | 2.9 | 2.7 | 2.5 | 2.4 | 2.2 | 2.1 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 33 |
| 34 | 3.5 | 3.2 | 3.0 | 2.8 | 2.6 | 2.4 | 2.3 | 2.1 | 2.0 | 1.9 | 1.7 | 1.6 | 1.5 | 34 |
| 35 | 3.7 | 3.4 | 3.1 | 2.9 | 2.7 | 2.5 | 2.3 | 2.2 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 35 |
| 36 | 3.9 | 3.6 | 3.3 | 3.0 | 2.8 | 2.6 | 2.4 | 2.3 | 2.1 | 2.0 | 1.8 | 1.7 | 1.6 | 36 |
| 37 | 4.1 | 3.7 | 3.4 | 3.2 | 2.9 | 2.7 | 2.5 | 2.3 | 2.2 | 2.0 | 1.9 | 1.7 | 1.6 | 37 |
| 38 | 4.3 | 3.9 | 3.6 | 3.3 | 3.0 | 2.8 | 2.6 | 2.4 | 2.2 | 2.1 | 1.9 | 1.8 | 1.7 | 38 |
| 39 | 4.6 | 4.2 | 3.8 | 3.5 | 3.2 | 2.9 | 2.7 | 2.5 | 2.3 | 2.1 | 2.0 | 1.8 | 1.7 | 39 |
| 40 | 5.0 | 4.5 | 4.0 | 3.7 | 3.3 | 3.1 | 2.8 | 2.6 | 2.4 | 2.2 | 2.0 | 1.9 | 1.8 | 40 |
| 41 | 5.4 | 4.8 | 4.3 | 3.9 | 3.5 | 3.2 | 2.9 | 2.7 | 2.5 | 2.3 | 2.1 | 1.9 | 1.8 | 41 |
| 42 | 5.9 | 5.2 | 4.6 | 4.1 | 3.7 | 3.4 | 3.1 | 2.8 | 2.6 | 2.4 | 2.2 | 2.0 | 1.9 | 42 |
| 43 | 6.5 | 5.7 | 5.0 | 4.4 | 4.0 | 3.6 | 3.2 | 2.9 | 2.7 | 2.5 | 2.3 | 2.1 | 1.9 | 43 |
| 44 | 7.3 | 6.3 | 5.4 | 4.8 | 4.3 | 3.8 | 3.4 | 3.1 | 2.8 | 2.6 | 2.3 | 2.2 | 2.0 | 44 |
| 45 | 8.4 | 7.0 | 6.0 | 5.2 | 4.6 | 4.1 | 3.6 | 3.3 | 3.0 | 2.7 | 2.4 | 2.2 | 2.0 | 45 |
| 46 | 9.9 | 8.0 | 6.7 | 5.8 | 5.0 | 4.4 | 3.9 | 3.5 | 3.1 | 2.8 | 2.6 | 2.3 | 2.1 | 46 |
| 47 | 12.1 | 9.5 | 7.7 | 6.5 | 5.5 | 4.8 | 4.2 | 3.7 | 3.3 | 3.0 | 2.7 | 2.4 | 2.2 | 47 |
| 48 |  | 11.6 | 9.1 | 7.4 | 6.2 | 5.3 | 4.6 | 4.0 | 3.6 | 3.2 | 2.8 | 2.6 | 2.3 | 48 |
| 49 |  |  | 11.1 | 8.7 | 7.1 | 5.9 | 5.0 | 4.4 | 3.8 | 3.4 | 3.0 | 2.7 | 2.4 | 49 |
| 50 |  |  |  | 10.6 | 8.3 | 6.8 | 5.6 | 4.8 | 4.2 | 3.6 | 3.2 | 2.9 | 2.6 | 50 |
| 51 |  |  |  |  | 10.2 | 7.9 | 6.4 | 5.4 | 4.6 | 4.0 | 3.5 | 3.0 | 2.7 | 51 |
| 52 |  |  |  |  |  | 9.7 | 7.6 | 6.1 | 5.1 | 4.3 | 3.8 | 3.3 | 2.9 | 52 |
| 53 |  |  |  |  |  |  | 9.2 | 7.2 | 5.9 | 4.9 | 4.1 | 3.6 | 3.1 | 53 |
| 54 |  |  |  |  |  |  |  | 8.8 | 6.8 | 5.5 | 4.6 | 3.9 | 3.4 | 54 |
| 55 | 10.2 |  |  |  |  |  |  |  | 8.3 | 6.5 | 5.3 | 4.3 | 3.7 | 55 |
| 56 | 7.9 | 9.7 |  |  |  |  |  |  |  | 7.9 | 6.1 | 5.0 | 4.1 | 56 |
| 57 | 6.4 | 7.6 | 9.2 |  |  |  |  |  |  |  | 7.4 | 5.8 | 4.7 | 57 |
| 58 | 5.4 | 6.1 | 7.2 | 8.8 |  |  |  |  |  |  |  | 7.0 | 5.4 | 58 |
| 59 | 4.6 | 5.1 | 5.9 | 6.8 | 8.3 |  |  |  |  |  |  |  | 6.6 | 59 |
| 60 | 4.0 | 4.3 | 4.9 | 5.5 | 6.5 | 7.9 |  |  |  |  |  |  |  | 60 |
|  | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | 61° | 62° | 63° |  |

Declination of the same name as the latitude; upper transit; reduction additive.

# TABLE 26.

### Variation of Altitude in one minute from meridian passage.

| Lati-tnde. | Declination of a different name from the latitude; upper transit; reduction additive. | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 1° | 2° | 3° | 4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | |
| ° | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ° |
| 0 | | | | | 28.1 | 22.4 | 18.7 | 16.0 | 14.0 | 12.4 | 11.1 | 10.1 | 0 |
| 1 | | | | 28.1 | 22.4 | 18.7 | 16.0 | 14.0 | 12.4 | 11.2 | 10.1 | 9.3 | 1 |
| 2 | | | 28.1 | 22.4 | 18.7 | 16.0 | 14.0 | 12.5 | 11.2 | 10.2 | 9.3 | 8.6 | 2 |
| 3 | | 28.1 | 22.4 | 18.7 | 16.0 | 14.0 | 12.5 | 11.2 | 10.2 | 9.3 | 8.6 | 8.0 | 3 |
| 4 | 28.1 | 22.4 | 18.7 | 16.0 | 14.0 | 12.5 | 11.2 | 10.2 | 9.3 | 8.6 | 8.0 | .7.4 | 4 |
| 5 | 22.4 | 18.7 | 16.0 | 14.0 | 12.5 | 11.2 | 10.2 | 9.3 | 8.6 | 8.0 | 7.4 | 7.0 | 5 |
| 6 | 18.7 | 16.0 | 14.0 | 12.5 | 11.2 | 10.2 | 9.3 | 8.6 | 8.0 | 7.5 | 7.0 | 6.6 | 6 |
| 7 | 16.0 | 14.0 | 12.4 | 11.2 | 10.2 | 9.3 | 8.6 | 8.0 | 7.5 | 7.0 | 6.6 | 6.2 | 7 |
| 8 | 14.0 | 12.4 | 11.2 | 10.2 | 9.3 | 8.6 | 8.0 | 7.5 | 7.0 | 6.6 | 6.2 | 5.9 | 8 |
| 9 | 12.4 | 11.2 | 10.2 | 9.3 | 8.6 | 8.0 | 7.5 | 7.0 | 6.6 | 6.2 | 5.9 | 5.6 | 9 |
| 10 | 11.1 | 10.1 | 9.3 | 8.6 | 8.0 | 7.4 | 7.0 | 6.6 | 6.2 | 5.9 | 5.6 | 5.3 | 10 |
| 11 | 10.1 | 9.3 | 8.6 | 8.0 | 7.4 | 7.0 | 6.6 | 6.2 | 5.9 | 5.6 | 5.3 | 5.1 | 11 |
| 12 | 9.2 | 8.5 | 7.9 | 7.4 | 7.0 | 6.5 | 6.2 | 5.9 | 5.6 | 5.3 | 5.0 | 4.8 | ·12 |
| 13 | 8.5 | 7.9 | 7.4 | 6.9 | 6.5 | 6.2 | 5.8 | 5.6 | 5.3 | 5.0 | 4.8 | 4.6 | 13 |
| 14 | 7.9 | 7.4 | 6.9 | 6.5 | 6.2 | 5.8 | 5.5 | 5.3 | 5.0 | 4.8 | 4.6 | 4.4 | 14 |
| 15 | 7.3 | 6.9 | 6.5 | 6.1 | 5.8 | 5.5 | 5.3 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 15 |
| 16 | 6.8 | 6.5 | 6.1 | 5.8 | 5.5 | 5.2 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.1 | 16 |
| 17 | 6.4 | 6.1 | 5.8 | 5.5 | 5.2 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.1 | 3.9 | 17 |
| 18 | 6.0 | 5.7 | 5.5 | 5.2 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.1 | 3.9 | 3.8 | 18 |
| 19 | 5.7 | 5.4 | 5.2 | 4.9 | 4.7 | 4.5 | 4.4 | 4.2 | 4.0 | 3.9 | 3.8 | 3.6 | 19 |
| 20 | 5.4 | 5.1 | 4.9 | 4.7 | 4.5 | 4.3 | 4.2 | 4.0 | 3.9 | 3.8 | 3.6 | 3.5 | 20 |
| 21 | 5.1 | 4.9 | 4.7 | 4.5 | 4.3 | 4.2 | 4.0 | 3.9 | 3.7 | 3.6 | 3.5 | 3.4 | 21 |
| 22 | 4.9 | 4.7 | 4.5 | 4.3 | 4.1 | 4.0 | 3.9 | 3.7 | 3.6 | 3.5 | 3.4 | 3.3 | 22 |
| 23 | 4.6 | 4.4 | 4.3 | 4.1 | 4.0 | 3.8 | 3.7 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 23 |
| 24 | 4.4 | 4.2 | 4.1 | 3.9 | 3.8 | 3.7 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 24 |
| 25 | 4.2 | 4.1 | 3.9 | 3.8 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.1 | 3.0 | 25 |
| 26 | 4.0 | 3.9 | 3.8 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 3.0 | 2.9 | 26 |
| 27 | 3.9 | 3.7 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.9 | 2.8 | 27 |
| 28 | 3.7 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 28 |
| 29 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | 29 |
| 30 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 3.0 | 2.9 | 2.8 | 2.7 | 2.7 | 2.6 | 2.5 | 30 |
| 31 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.5 | 31 |
| 32 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | .2.6 | 2.5 | 2.5 | 2.4 | 32 |
| 33 | 3.0 | 2.9 | 2.9 | 2.8 | 2.7 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 33 |
| 34 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 34 |
| 35 | 2.8 | 2.7 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 35 |
| 36 | 2.7 | 2.6 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 36 |
| 37 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 37 |
| 38 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 38 |
| 39 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 39 |
| 40 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | · 2.0 | 2.0 | 1.9 | 1.9 | 40 |
| 41 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 41 |
| 42 | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 42 |
| 43 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 43 |
| 44 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 44 |
| 45 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 45 |
| 46 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 46 |
| 47 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 47 |
| 48 | 1.8 | ·1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 48 |
| 49 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 49 |
| 50 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 50 |
| 51 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 51 |
| 52 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 52 |
| 53 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 53 |
| 54 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 54 |
| 55 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 55 |
| 56 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 56 |
| 57 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 57 |
| 58 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 58 |
| 59 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1,1 | 1.1 | 1.1 | 59 |
| 60 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1 0 | 1.0 | 1.0 | 60 |
| | 0° | 1° | 2° | 3° | .4° | 5° | 6° | 7° | 8° | 9° | 10° | 11° | |

Declination of a different name from the latitude; upper transit; reduction additive.

# TABLE 26.

## Variation of Altitude in one minute from meridian passage.

| Lati-tude. | Declination of a different name from the latitude; upper transit; reduction additive. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 24° | |
| ° | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | ° |
| 0 | 9.2 | 8.5 | 7.9 | 7.3 | 6.8 | 6.4 | 6.0 | 5.7 | 5.4 | 5.1 | 4.9 | 4.6 | 4.4 | 0 |
| 1 | 8.5 | 7.9 | 7.4 | 6.9 | 6.5 | 6.1 | 5.7 | 5.4 | 5.1 | 4.9 | 4.7 | 4.4 | 4.2 | 1 |
| 2 | 7.9 | 7.4 | 6.9 | 6.5 | 6.1 | 5.8 | 5.5 | 5.2 | 4.9 | 4.7 | 4.5 | 4.3 | 4.1 | 2 |
| 3 | 7.4 | 6.9 | 6.5 | 6.1 | 5.8 | 5.5 | 5.2 | 4.9 | 4.7 | 4.5 | 4.3 | 4.1 | 3.9 | 3 |
| 4 | 7.0 | 6.5 | 6.2 | 5.8 | 5.5 | 5.2 | 5.0 | 4.7 | 4.5 | 4.3 | 4.1 | 4.0 | 3.8 | 4 |
| 5 | 6.5 | 6.2 | 5.8 | 5.5 | 5.2 | 5.0 | 4.8 | 4.5 | 4.3 | 4.2 | 4.0 | 3.8 | 3.7 | 5 |
| 6 | 6.2 | 5.8 | 5.5 | 5.3 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.0 | 3.9 | 3.7 | 3.6 | 6 |
| 7 | 5.9 | 5.6 | 5.3 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.0 | 3.9 | 3.7 | 3.6 | 3.5 | 7 |
| 8 | 5.6 | 5.3 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.0 | 3.9 | 3.7 | 3.6 | 3.5 | 3.4 | 8 |
| 9 | 5.3 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.1 | 3.9 | 3.8 | 3.6 | 3.5 | 3.4 | 3.3 | 9 |
| 10 | 5.0 | 4.8 | 4.6 | 4.4 | 4.2 | 4.1 | 3.9 | 3.8 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 10 |
| 11 | 4.8 | 4.6 | 4.4 | 4.2 | 4.1 | 3.9 | 3.8 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 11 |
| 12 | 4.6 | 4.4 | 4.3 | 4.1 | 3.9 | 3.8 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 12 |
| 13 | 4.4 | 4.3 | 4.1 | 3.9 | 3.8 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 13 |
| 14 | 4.2 | 4.1 | 3.9 | 3.8 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 14 |
| 15 | 4.1 | 3.9 | 3.8 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 15 |
| 16 | 3.9 | 3.8 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 16 |
| 17 | 3.8 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | 17 |
| 18 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 18 |
| 19 | 3.5 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 19 |
| 20 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.4 | 20 |
| 21 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.4 | 2.4 | 21 |
| 22 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 22 |
| 23 | 3.1 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 23 |
| 24 | 3.0 | 2.9 | 2.8 | 2.8 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 24 |
| 25 | 2.9 | 2.8 | 2.7 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 25 |
| 26 | 2.8 | 2.7 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.1 | 26 |
| 27 | 2.7 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 | 27 |
| 28 | 2.6 | 2.6 | 2.5 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 28 |
| 29 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 29 |
| 30 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 30 |
| 31 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 31 |
| 32 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 32 |
| 33 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 33 |
| 34 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 34 |
| 35 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 35 |
| 36 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 36 |
| 37 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 37 |
| 38 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 38 |
| 39 | 1.9 | 1.9 | 1.9 | 1:8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 39 |
| 40 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 40 |
| 41 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 41 |
| 42 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 42 |
| 43 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 43 |
| 44 | 1.7 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 44 |
| 45 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 45 |
| 46 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 46 |
| 47 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 47 |
| 48 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 48 |
| 49 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 49 |
| 50 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 50 |
| 51 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 51 |
| 52 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 52 |
| 53 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 53 |
| 54 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 54 |
| 55 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 55 |
| 56 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 56 |
| 57 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 57 |
| 58 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 58 |
| 59 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 59 |
| 60 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 60 |
| | 12° | 13° | 14° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | 24° | |

Declination of a different name from the latitude; upper transit; reduction additive.

## TABLE 26.

### Variation of Altitude in one minute from meridian passage.

| Latitude. | Declination of a different name from the latitude; upper transit; reduction additive. | | | | | | | | | | | | | Latitude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° | ° |
|  | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |  |
| 0 | 4.2 | 4.0 | 3.9 | 3.7 | 3.5 | 3.4 | 3.3 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 0 |
| 1 | 4.1 | 3.9 | 3.7 | 3.6 | 3.4 | 3.3 | 3.2 | 3.1 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 1 |
| 2 | 3.9 | 3.8 | 3.6 | 3.5 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2 |
| 3 | 3.8 | 3.6 | 3.5 | 3.4 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 3 |
| 4 | 3.7 | 3.5 | 3.4 | 3.3 | 3.2 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.4 | 4 |
| 5 | 3.6 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 5 |
| 6 | 3.4 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 6 |
| 7 | 3.3 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.3 | 2.2 | 7 |
| 8 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 8 |
| 9 | 3.1 | 3.0 | 2.9 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | 2.2 | 9 |
| 10 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 10 |
| 11 | 3.0 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.1 | 11 |
| 12 | 2.9 | 2.8 | 2.7 | 2.6 | 2.6 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 12 |
| 13 | 2.8 | 2.7 | 2.7 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 13 |
| 14 | 2.7 | 2.7 | 2.6 | 2.5 | 2.4 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 14 |
| 15 | 2.7 | 2.6 | 2.5 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 15 |
| 16 | 2.6 | 2.5 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 16 |
| 17 | 2.5 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 17 |
| 18 | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 18 |
| 19 | 2.4 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 19 |
| 20 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 20 |
| 21 | 2.3 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 21 |
| 22 | 2.3 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 22 |
| 23 | 2.2 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 23 |
| 24 | 2.2 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 24 |
| 25 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 25 |
| 26 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 26 |
| 27 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 27 |
| 28 | 2.0 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 28 |
| 29 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 29 |
| 30 | 1.9 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 30 |
| 31 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 31 |
| 32 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 32 |
| 33 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 33 |
| 34 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 34 |
| 35 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 35 |
| 36 | 1.6 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 36 |
| 37 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 37 |
| 38 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 38 |
| 39 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 39 |
| 40 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 40 |
| 41 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 41 |
| 42 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 42 |
| 43 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 43 |
| 44 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 44 |
| 45 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 45 |
| 46 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 46 |
| 47 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 47 |
| 48 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |  | 48 |
| 49 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |  |  | 49 |
| 50 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |  |  | 50 |
| 51 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 |  |  |  |  | 51 |
| 52 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 |  |  |  |  |  | 52 |
| 53 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  | 53 |
| 54 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  |  | 54 |
| 55 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  |  |  | 55 |
| 56 | 1.0 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  |  |  |  | 56 |
| 57 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  |  |  |  |  | 57 |
| 58 | 1.0 | 0.9 |  |  |  |  |  |  |  |  |  |  |  | 58 |
| 59 | 0.9 |  |  |  |  |  |  |  |  |  |  |  | 0.8 | 59 |
| 60 |  |  |  |  |  |  |  |  |  |  |  | 0.8 | 0.8 | 60 |
|  | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | 34° | 35° | 36° | 37° |  |

Declination of the same name as the latitude; lower transit; reduction subtractive.

TABLE 26. [Page 549

Variation of Altitude in one minute from meridian passage.

| Lati-tude. | Declination of a different name from the latitude; upper transit; reduction additive. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | 50° | |
| ° | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ° |
| 0 | 2.5 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 0 |
| 1 | 2.5 | 2.4 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.7 | 1.7 | 1.6 | 1 |
| 2 | 2.4 | 2.3 | 2.3 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 2 |
| 3 | 2.4 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.6 | 3 |
| 4 | 2.3 | 2.2 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 4 |
| 5 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 5 |
| 6 | 2.2 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 6 |
| 7 | 2.2 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 7 |
| 8 | 2.1 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 8 |
| 9 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 9 |
| 10 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 10 |
| 11 | 2.0 | 2.0 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 11 |
| 12 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 12 |
| 13 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 13 |
| 14 | 1.9 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 14 |
| 15 | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 15 |
| 16 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 16 |
| 17 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 17 |
| 18 | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 18 |
| 19 | 1.7 | 1.7 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 19 |
| 20 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 20 |
| 21 | 1.7 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 21 |
| 22 | 1.7 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 22 |
| 23 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 23 |
| 24 | 1.6 | 1.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 24 |
| 25 | 1.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 25 |
| 26 | 1.6 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 26 |
| 27 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 27 |
| 28 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 28 |
| 29 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 29 |
| 30 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 30 |
| 31 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 31 |
| 32 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 32 |
| 33 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 33 |
| 34 | 1.4 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 34 |
| 35 | 1.3 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | | 35 |
| 36 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | | | 36 |
| 37 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | | | | 37 |
| 38 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | | | | | 38 |
| 39 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | | | | | | 39 |
| 40 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | | | | | | | 40 |
| 41 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | | | | | | | | 41 |
| 42 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | | | | | | | | | 42 |
| 43 | 1.2 | 1.1 | 1.1 | 1.1 | | | | | | | | | | 43 |
| 44 | 1.1 | 1.1 | 1.1 | | | | | | | | | | | 44 |
| 45 | 1.1 | 1.1 | | | | | | | | | | | 0.9 | 45 |
| 46 | 1.1 | | | | | | | | | | | 0.9 | 0.9 | 46 |
| 47 | | | | | | | | | | | 0.9 | 0.9 | 0.9 | 47 |
| 48 | | | | | | | | | | 0.9 | 0.9 | 0.9 | 0.9 | 48 |
| 49 | | | | | | | | | | 0.9 | 0.9 | 0.9 | 0.8 | 49 |
| 50 | | | | | | | | | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 50 |
| 51 | | | | | | | | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 51 |
| 52 | | | | | | | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 52 |
| 53 | | | | | | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 53 |
| 54 | | | | | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 54 |
| 55 | | | | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 55 |
| 56 | | | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 56 |
| 57 | | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 57 |
| 58 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 58 |
| 59 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 59 |
| 60 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 60 |
| | 38° | 39° | 40° | 41° | 42° | 43° | 44° | 45° | 46° | 47° | 48° | 49° | 50° | |

Declination of the same name as the latitude; lower transit; reduction subtractive.

# TABLE 26.

### Variation of Altitude in one minute from meridian passage.

| Lati-tude. | Declination of a **different** name from the latitude; upper transit; reduction **additive.** | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | 61° | 62° | 63° |  |
| 0 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 0 |
| 1 | 1.6 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1 |
| 2 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 2 |
| 3 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 3 |
| 4 | 1.5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 4 |
| 5 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 5 |
| 6 | 1.5 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 6 |
| 7 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3* | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 0.9 | 7 |
| 8 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 0.9 | 8 |
| 9 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 9 |
| 10 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 10 |
| 11 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 11 |
| 12 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 0.9 | 0.9 | 12 |
| 13 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 13 |
| 14 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 14 |
| 15 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 15 |
| 16 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 16 |
| 17 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 17 |
| 18 | 1.3 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 18 |
| 19 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 19 |
| 20 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 | 20 |
| 21 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 | 21 |
| 22 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 |  | 22 |
| 23 | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 |  |  | 23 |
| 24 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 |  |  |  | 24 |
| 25 | 1.2 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 |  |  |  |  | 25 |
| 26 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 |  |  |  |  |  | 26 |
| 27 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  | 27 |
| 28 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  |  | 28 |
| 29 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 |  |  |  |  |  |  |  |  | 29 |
| 30 | 1.1 | 1.1 | 1.0 | 1.0 |  |  |  |  |  |  |  |  |  | 30 |
| 31 | 1.1 | 1.0 | 1.0 |  |  |  |  |  |  |  |  |  |  | 31 |
| 32 | 1.1 | 1.0 |  |  |  |  |  |  |  |  |  |  |  | 32 |
| 33 | 1.1 |  |  |  |  |  |  |  |  |  |  |  | 0.8 | 33 |
| 34 |  |  |  |  |  |  |  |  |  |  |  | 0.8 | 0.7 | 34 |
| 35 |  |  |  |  |  |  |  |  |  |  | 0.8 | 0.8 | 0.7 | 35 |
| 36 |  |  |  |  |  |  |  |  |  | 0.8 | 0.8 | 0.8 | 0.7 | 36 |
| 37 |  |  |  |  |  |  |  |  | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 37 |
| 38 |  |  |  |  |  |  |  | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 38 |
| 39 |  |  |  |  |  |  | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 39 |
| 40 |  |  |  |  |  | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 40 |
| 41 |  |  |  |  | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 41 |
| 42 |  |  |  | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 42 |
| 43 |  |  | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 43 |
| 44 |  | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 44 |
| 45 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 45 |
| 46 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 46 |
| 47 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 47 |
| 48 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 48 |
| 49 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 49 |
| 50 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 50 |
| 51 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 51 |
| 52 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 52 |
| 53 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 53 |
| 54 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 54 |
| 55 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 55 |
| 56 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 56 |
| 57 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 57 |
| 58 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 58 |
| 59 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 59 |
| 60 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 60 |
|  | 51° | 52° | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | 61° | 62° | 63° |  |

Declination of the **same** name as the latitude; **lower transit;** reduction **subtractive.**

TABLE 27. [Page 551

Reduction to be applied to Altitudes near the Meridian.

| Var. 1 min. (Table 26.) | Time from meridian passage. | | | | | | | | | | | | | Var. 1 min. (Table 26.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m. s. 0 30 | m. s. 1 0 | m. s. 1 30 | m. s. 2 0 | m. s. 2 30 | m. s. 3 0 | m. s. 3 30 | m. s. 4 0 | m. s. 4 30 | m. s. 5 0 | m. s. 5 30 | m. s. 6 0 | m. s. 6 30 | |
| ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ″ |
| 0.1 | 0 0 | 0 0 | 0 0 | 0 0 | 0 1 | 0 1 | 0 1 | 0 2 | 0 2 | 0 2 | 0 3 | 0 4 | 0 4 | 0.1 |
| 0.2 | 0 0 | 0 0 | 0 0 | 0 1 | 0 1 | 0 2 | 0 3 | 0 3 | 0 4 | 0 5 | 0 6 | 0 7 | 0 8 | 0.2 |
| 0.3 | 0 0 | 0 0 | 0 1 | 0 1 | 0 2 | 0 3 | 0 4 | 0 5 | 0 6 | 0 7 | 0 9 | 0 11 | 0 13 | 0.3 |
| 0.4 | 0 0 | 0 0 | 0 1 | 0 2 | 0 2 | 0 4 | 0 5 | 0 6 | 0 8 | 0 10 | 0 12 | 0 14 | 0 17 | 0.4 |
| 0.5 | 0 0 | 0 0 | 0 1 | 0 2 | 0 3 | 0 4 | 0 6 | 0 8 | 0 10 | 0 12 | 0 15 | 0 18 | 0 21 | 0.5 |
| 0.6 | 0 0 | 0 1 | 0 1 | 0 2 | 0 4 | 0 5 | 0 7 | 0 10 | 0 12 | 0 15 | 0 18 | 0 22 | 0 25 | 0.6 |
| 0.7 | 0 0 | 0 1 | 0 2 | 0 3 | 0 4 | 0 6 | 0 9 | 0 11 | 0 14 | 0 17 | 0 21 | 0 25 | 0 30 | 0.7 |
| 0.8 | 0 0 | 0 1 | 0 2 | 0 3 | 0 5 | 0 7 | 0 10 | 0 13 | 0 16 | 0 20 | 0 24 | 0 29 | 0 34 | 0.8 |
| 0.9 | 0 0 | 0 1 | 0 2 | 0 4 | 0 6 | 0 8 | 0 11 | 0 14 | 0 18 | 0 22 | 0 27 | 0 32 | 0 38 | 0.9 |
| 1.0 | 0 0 | 0 1 | 0 2 | 0 4 | 0 6 | 0 9 | 0 12 | 0 16 | 0 20 | 0 25 | 0 30 | 0 36 | 0 42 | 1.0 |
| 2.0 | 0 0 | 0 2 | 0 4 | 0 8 | 0 12 | 0 18 | 0 24 | 0 32 | 0 41 | 0 50 | 1 0 | 1 12 | 1 24 | 2.0 |
| 3.0 | 0 1 | 0 3 | 0 7 | 0 12 | 0 19 | 0 27 | 0 37 | 0 48 | 1 1 | 1 15 | 1 31 | 1 48 | 2 6 | 3.0 |
| 4.0 | 0 1 | 0 4 | 0 9 | 0 16 | 0 25 | 0 36 | 0 49 | 1 4 | 1 21 | 1 40 | 2 1 | 2 24 | 2 49 | 4.0 |
| 5.0 | 0 1 | 0 5 | 0 11 | 0 20 | 0 31 | 0 45 | 1 1 | 1 20 | 1 41 | 2 5 | 2 31 | 3 0 | 3 31 | 5.0 |
| 6.0 | 0 1 | 0 6 | 0 13 | 0 24 | 0 37 | 0 54 | 1 13 | 1 36 | 2 1 | 2 30 | 3 1 | 3 36 | 4 13 | 6.0 |
| 7.0 | 0 2 | 0 7 | 0 16 | 0 28 | 0 44 | 1 3 | 1 26 | 1 52 | 2 22 | 2 55 | 3 32 | 4 12 | 4 56 | 7.0 |
| 8.0 | 0 2 | 0 8 | 0 18 | 0 32 | 0 50 | 1 12 | 1 38 | 2 8 | 2 42 | 3 20 | 4 2 | 4 48 | 5 38 | 8.0 |
| 9.0 | 0 2 | 0 9 | 0 20 | 0 36 | 0 56 | 1 21 | 1 50 | 2 24 | 3 2 | 3 45 | 4 32 | 5 24 | 6 20 | 9.0 |
| 10.0 | 0 2 | 0 10 | 0 22 | 0 40 | 1 2 | 1 30 | 2 3 | 2 40 | 3 23 | 4 10 | 5 2 | 6 0 | 7 2 | 10.0 |
| 11.0 | 0 3 | 0 11 | 0 25 | 0 44 | 1 9 | 1 39 | 2 15 | 2 56 | 3 43 | 4 35 | 5 32 | 6 36 | 7 45 | 11.0 |
| 12.0 | 0 3 | 0 12 | 0 27 | 0 48 | 1 15 | 1 48 | 2 27 | 3 12 | 4 3 | 5 0 | 6 3 | 7 12 | 8 27 | 12.0 |
| 13.0 | 0 3 | 0 13 | 0 29 | 0 52 | 1 21 | 1 57 | 2 39 | 3 28 | 4 23 | 5 25 | 6 33 | 7 48 | 9 9 | 13.0 |
| 14.0 | 0 3 | 0 14 | 0 31 | 0 56 | 1 27 | 2 6 | 2 51 | 3 44 | 4 43 | 5 50 | 7 4 | 8 24 | 9 51 | 14.0 |
| 15.0 | 0 4 | 0 15 | 0 34 | 1 0 | 1 34 | 2 15 | 3 4 | 4 0 | 5 3 | 6 15 | 7 34 | 9 0 | 10 34 | 15.0 |
| 16.0 | 0 4 | 0 16 | 0 36 | 1 4 | 1 40 | 2 24 | 3 16 | 4 16 | 5 24 | 6 40 | 8 4 | 9 36 | 11 16 | 16.0 |
| 17.0 | 0 4 | 0 17 | 0 38 | 1 8 | 1 46 | 2 33 | 3 28 | 4 32 | 5 44 | 7 5 | 8 34 | 10 12 | 11 58 | 17.0 |
| 18.0 | 0 4 | 0 18 | 0 40 | 1 12 | 1 52 | 2 42 | 3 40 | 4 48 | 6 4 | 7 30 | 9 4 | 10 48 | 12 40 | 18.0 |
| 19.0 | 0 5 | 0 19 | 0 43 | 1 16 | 1 59 | 2 51 | 3 53 | 5 4 | 6 25 | 7 55 | 9 35 | 11 24 | 13 23 | 19.0 |
| 20.0 | 0 5 | 0 20 | 0 45 | 1 20 | 2 5 | 3 0 | 4 5 | 5 20 | 6 45 | 8 20 | 10 5 | 12 0 | 14 5 | 20.0 |
| 21.0 | 0 5 | 0 21 | 0 47 | 1 24 | 2 11 | 3 9 | 4 17 | 5 36 | 7 5 | 8 45 | 10 35 | 12 36 | 14 47 | 21.0 |
| 22.0 | 0 5 | 0 22 | 0 49 | 1 28 | 2 17 | 3 18 | 4 30 | 5 52 | 7 25 | 9 10 | 11 5 | 13 12 | 15 29 | 22.0 |
| 23.0 | 0 6 | 0 23 | 0 52 | 1 32 | 2 24 | 3 27 | 4 42 | 6 8 | 7 46 | 9 35 | 11 36 | 13 48 | 16 12 | 23.0 |
| 24.0 | 0 6 | 0 24 | 0 54 | 1 36 | 2 30 | 3 36 | 4 54 | 6 24 | 8 6 | 10 0 | 12 6 | 14 24 | 16 54 | 24.0 |
| 25.0 | 0 6 | 0 25 | 0 56 | 1 40 | 2 36 | 3 45 | 5 6 | 6 40 | 8 26 | 10 25 | 12 36 | 15 0 | | 25.0 |
| 26.0 | 0 6 | 0 26 | 0 58 | 1 44 | 2 42 | 3 54 | 5 18 | 6 56 | 8 46 | 10 50 | 13 6 | | | 26.0 |
| 27.0 | 0 7 | 0 27 | 1 1 | 1 48 | 2 49 | 4 3 | 5 30 | 7 12 | 9 7 | 11 15 | | | | 27.0 |
| 28.0 | 0 7 | 0 28 | 1 3 | 1 52 | 2 55 | 4 12 | 5 43 | 7 28 | 9 27 | 11 40 | | | | 28.0 |

# TABLE 27.

### Reduction to be applied to Altitudes near the Meridian.

| Var. 1 min. (Table 26.) | Time from meridian passage. | | | | | | | | | | | | | Var. 1 min. (Table 26.) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | m. s. 7 0 | m. s. 7 30 | m. s. 8 0 | m. s. 8 30 | m. s. 9 0 | m. s. 9 30 | m. s. 10 0 | m. s. 10 30 | m. s. 11 0 | m. s. 11 30 | m. s. 12 0 | m. s. 12 30 | m. s. 13 0 | |
| 0.1 | 0 5 | 0 6 | 0 6 | 0 7 | 0 8 | 0 9 | 0 10 | 0 11 | 0 12 | 0 13 | 0 14 | 0 16 | 0 17 | 0.1 |
| 0.2 | 0 10 | 0 11 | 0 13 | 0 14 | 0 16 | 0 18 | 0 20 | 0 22 | 0 24 | 0 26 | 0 29 | 0 31 | 0 34 | 0.2 |
| 0.3 | 0 15 | 0 17 | 0 19 | 0 22 | 0 24 | 0 27 | 0 30 | 0 33 | 0 36 | 0 40 | 0 43 | 0 47 | 0 51 | 0.3 |
| 0.4 | 0 20 | 0 23 | 0 26 | 0 29 | 0 32 | 0 36 | 0 40 | 0 44 | 0 48 | 0 53 | 0 58 | 1 2 | 1 8 | 0.4 |
| 0.5 | 0 24 | 0 28 | 0 32 | 0 36 | 0 40 | 0 45 | 0 50 | 0 55 | 1 0 | 1 6 | 1 12 | 1 18 | 1 24 | 0.5 |
| 0.6 | 0 29 | 0 34 | 0 38 | 0 43 | 0 49 | 0 54 | 1 0 | 1 6 | 1 13 | 1 19 | 1 26 | 1 34 | 1 41 | 0.6 |
| 0.7 | 0 34 | 0 39 | 0 45 | 0 51 | 0 57 | 1 3 | 1 10 | 1 17 | 1 25 | 1 33 | 1 41 | 1 49 | 1 58 | 0.7 |
| 0.8 | 0 39 | 0 45 | 0 51 | 0 58 | 1 5 | 1 12 | 1 20 | 1 28 | 1 37 | 1 46 | 1 55 | 2 5 | 2 15 | 0.8 |
| 0.9 | 0 44 | 0 51 | 0 57 | 1 5 | 1 13 | 1 21 | 1 30 | 1 39 | 1 49 | 1 59 | 2 10 | 2 21 | 2 32 | 0.9 |
| 1.0 | 0 49 | 0 56 | 1 4 | 1 12 | 1 21 | 1 30 | 1 40 | 1 50 | 2 1 | 2 12 | 2 24 | 2 36 | 2 49 | 1.0 |
| 2.0 | 1 38 | 1 52 | 2 8 | 2 24 | 2 42 | 3 0 | 3 20 | 3 40 | 4 2 | 4 24 | 4 48 | 5 12 | 5 38 | 2.0 |
| 3.0 | 2 27 | 2 49 | 3 12 | 3 37 | 4 3 | 4 30 | 5 0 | 5 31 | 6 3 | 6 37 | 7 12 | 7 49 | 8 27 | 3.0 |
| 4.0 | 3 16 | 3 45 | 4 16 | 4 49 | 5 24 | 6 1 | 6 40 | 7 21 | 8 4 | 8 49 | 9 36 | 10 25 | 11 16 | 4.0 |
| 5.0 | 4 5 | 4 41 | 5 20 | 6 1 | 6 45 | 7 31 | 8 20 | 9 11 | 10 5 | 11 1 | 12 0 | 13 1 | 14 5 | 5.0 |
| 6.0 | 4 54 | 5 37 | 6 24 | 7 14 | 8 6 | 9 1 | 10 0 | 11 1 | 12 6 | 13 13 | 14 24 | 15 37 | 16 54 | 6.0 |
| 7.0 | 5 43 | 6 34 | 7 28 | 8 26 | 9 27 | 10 32 | 11 40 | 12 52 | 14 7 | 15 26 | 16 48 | 18 14 | 19 43 | 7.0 |
| 8.0 | 6 32 | 7 30 | 8 32 | 9 38 | 10 48 | 12 2 | 13 20 | 14 42 | 16 8 | 17 38 | 19 12 | 20 50 | 22 32 | 8.0 |
| 9.0 | 7 21 | 8 26 | 9 36 | 10 50 | 12 9 | 13 32 | 15 0 | 16 32 | 18 9 | 19 50 | 21 36 | 23 26 | 25 21 | 9.0 |
| 10.0 | 8 10 | 9 22 | 10 40 | 12 2 | 13 30 | 15 2 | 16 40 | 18 22 | 20 10 | 22 2 | 24 0 | 26 2 | 28 10 | 10.0 |
| 11.0 | 8 59 | 10 19 | 11 44 | 13 15 | 14 51 | 16 33 | 18 20 | 20 13 | 22 11 | 24 15 | 26 24 | 28 39 | | 11.0 |
| 12.0 | 9 48 | 11 15 | 12 48 | 14 27 | 16 12 | 18 3 | 20 0 | 22 3 | 24 12 | 26 27 | 28 48 | | | 12.0 |
| 13.0 | 10 37 | 12 11 | 13 52 | 15 39 | 17 33 | 19 33 | 21 40 | 23 53 | 26 13 | 28 39 | | | | 13.0 |
| 14.0 | 11 26 | 13 7 | 14 56 | 16 51 | 18 54 | 21 3 | 23 20 | 25 43 | 28 14 | | | | | 14.0 |
| 15.0 | 12 15 | 14 4 | 16 0 | 18 14 | 20 15 | 22 34 | 25 0 | 27 34 | | | | | | 15.0 |
| 16.0 | 13 4 | 15 0 | 17 4 | 19 16 | 21 36 | 24 4 | 26 40 | | | | | | | 16.0 |
| 17.0 | 13 53 | 15 56 | 18 8 | 20 28 | 22 57 | 25 34 | | | | | | | | 17.0 |
| 18.0 | 14 42 | 16 52 | 19 12 | 21 40 | 24 18 | | | | | | | | | 18.0 |
| 19.0 | 15 31 | 17 49 | 20 16 | | | | | | | | | | | 19.0 |
| 20.0 | 16 20 | 18 45 | | | | | | | | | | | | 20.0 |
| 21.0 | 17 9 | | | | | | | | | | | | | 21.0 |

# TABLE 27.

### Reduction to be applied to Altitudes near the Meridian

| Var. 1 min. (Table 26.) | 13 30 | 14 0 | 14 30 | 15 0 | 15 30 | 16 0 | 16 30 | 17 0 | 17 30 | 18 0 | 18 30 | 19 0 | 19 30 | Var. 1 min. (Table 26.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | |
| 0.1 | 0 18 | 0 20 | 0 21 | 0 22 | 0 24 | 0 26 | 0 27 | 0 29 | 0 31 | 0 32 | 0 34 | 0 36 | 0 38 | 0.1 |
| 0.2 | 0 36 | 0 39 | 0 42 | 0 45 | 0 48 | 0 51 | 0 54 | 0 58 | 1 1 | 1 5 | 1 8 | 1 12 | 1 16 | 0.2 |
| 0.3 | 0 55 | 0 59 | 1 3 | 1 7 | 1 12 | 1 17 | 1 22 | 1 27 | 1 32 | 1 37 | 1 43 | 1 48 | 1 54 | 0.3 |
| 0.4 | 1 13 | 1 18 | 1 24 | 1 30 | 1 36 | 1 42 | 1 49 | 1 56 | 2 2 | 2 10 | 2 17 | 2 24 | 2 32 | 0.4 |
| 0.5 | 1 31 | 1 38 | 1 45 | 1 52 | 2 0 | 2 8 | 2 16 | 2 24 | 2 33 | 2 42 | 2 51 | 3 1 | 3 10 | 0.5 |
| 0.6 | 1 49 | 1 58 | 2 6 | 2 15 | 2 24 | 2 34 | 2 43 | 2 53 | 3 4 | 3 14 | 3 25 | 3 37 | 3 48 | 0.6 |
| 0.7 | 2 8 | 2 17 | 2 27 | 2 37 | 2 48 | 2 59 | 3 11 | 3 22 | 3 34 | 3 47 | 4 0 | 4 13 | 4 26 | 0.7 |
| 0.8 | 2 26 | 2 37 | 2 48 | 3 0 | 3 12 | 3 25 | 3 38 | 3 51 | 4 5 | 4 19 | 4 34 | 4 49 | 5 4 | 0.8 |
| 0.9 | 2 44 | 2 56 | 3 9 | 3 22 | 3 36 | 3 50 | 4 5 | 4 20 | 4 36 | 4 52 | 5 8 | 5 25 | 5 42 | 0.9 |
| 1.0 | 3 2 | 3 16 | 3 30 | 3 45 | 4 0 | 4 16 | 4 32 | 4 49 | 5 6 | 5 24 | 5 42 | 6 1 | 6 20 | 1.0 |
| 2.0 | 6 4 | 6 32 | 7 0 | 7 30 | 8 0 | 8 32 | 9 4 | 9 38 | 10 12 | 10 48 | 11 24 | 12 2 | 12 40 | 2.0 |
| 3.0 | 9 7 | 9 48 | 10 30 | 11 15 | 12 1 | 12 48 | 13 38 | 14 27 | 15 19 | 16 12 | 17 7 | 18 3 | 19 1 | 3.0 |
| 4.0 | 12 9 | 13 14 | 14 1 | 15 0 | 16 1 | 17 4 | 18 9 | 19 16 | 20 25 | 21 36 | 22 49 | 24 4 | 25 21 | 4.0 |
| 5.0 | 15 11 | 16 20 | 17 31 | 18 45 | 20 1 | 21 20 | 22 41 | 24 5 | 25 31 | 27 0 | 28 31 | | | 5.0 |
| 6.0 | 18 13 | 19 36 | 21 2 | 22 30 | 24 1 | 25 36 | 27 13 | | | | | | | 6.0 |
| 7.0 | 21 16 | 22 52 | 24 32 | 26 15 | 28 1 | | | | | | | | | 7.0 |
| 8.0 | 24 18 | 26 8 | 28 2 | | | | | | | | | | | 8.0 |
| 9.0 | 27 20 | | | | | | | | | | | | | 9.0 |

| Var. 1 min. (Table 26.) | 20 0 | 20 30 | 21 0 | 21 30 | 22 0 | 22 30 | 23 0 | 23 30 | 24 0 | 24 30 | 25 0 | 25 30 | 26 0 | Var. 1 min. (Table 26.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | m. s. | |
| 0.1 | 0 40 | 0 42 | 0 44 | 0 46 | 0 48 | 0 51 | 0 53 | 0 55 | ·0 58 | 1 0 | 1 2 | 1 6 | 1 8 | 0.1 |
| 0.2 | 1 20 | 1 24 | 1 28 | 1 32 | 1 37 | 1 41 | 1 46 | 1 50 | 1 55 | 2 0 | 2 5 | 2 10 | 2 15 | 0.2 |
| 0.3 | 2 0 | 2 6 | 2 12 | 2 19 | 2 25 | 2 32 | 2 39 | 2 46 | 2 53 | 3 0 | 3 7 | 3 15 | 3 23 | 0.3 |
| 0.4 | 2 40 | 2 48 | 2 56 | 3 5 | 3 14 | 3 22 | 3 32 | 3 41 | 3 50 | 4 0 | 4 10 | 4 20 | 4 30 | 0.4 |
| 0.5 | 3 20 | 3 30 | 3 41 | 3 51 | 4 2 | 4 13 | 4 24 | 4 36 | 4 48 | 5 0 | 5 12 | 5 25 | 5 38 | 0.5 |
| 0.6 | 4 0 | 4 12 | 4 25 | 4 37 | 4 50 | 5 4 | 5 17 | 5 31 | 5 46 | 6 0 | 6 15 | 6 30 | 6 46 | 0.6 |
| 0.7 | 4 40 | 4 54 | 5 9 | 5 24 | 5 39 | 5 54 | 6 10 | 6 27 | 6 43 | 7 0 | 7 17 | 7 35 | 7 53 | 0.7 |
| 0.8 | 5 20 | 5 36 | 5 53 | 6 10 | 6 27 | 6 45 | 7 3 | 7 22 | 7 41 | 8 0 | 8 20 | 8 40 | 9 1 | 0.8 |
| 0.9 | 6 0 | 6 18 | 6 37 | 6 56 | 7 16 | 7 36 | 7 56 | 8 17 | 8 38 | 9 0 | 9 22 | 9 45 | 10 8 | 0.9 |
| 1.0 | 6 40 | 7 0 | 7 21 | 7 42 | 8 4 | 8 26 | 8 49 | 9 12 | 9 36 | 10 0 | 10 25 | 10 50 | 11 16 | 1.0 |
| 2.0 | 13 20 | 14 0 | 14 42 | 15 24 | 16 8 | 16 52 | 17 38 | 18 24 | 19 12 | 20 0 | 20 50 | 21 40 | 22 32 | 2.0 |
| 3.0 | 20 0 | 21 0 | 22 3 | 23 7 | 24 12 | 25 19 | 26 27 | 27 37 | 28 48 | 30 0 | | | | 3.0 |
| 4.0 | 26 40 | 28 1 | 29 24 | | | | | | | | | | | 4.0 |

# TABLE 28A.

### For finding the Latitude of a place by Altitudes of Polaris.

[A = 1st correction.   Argument, the star's hour angle (or 24ʰ−the star's hour angle).]

| m. | 0ʰ ° ′ ″ | ″ | 1ʰ ° ′ ″ | ″ | 2ʰ ° ′ ″ | ″ | 3ʰ ° ′ ″ | ″ | 4ʰ ° ′ ″ | ″ | 5ʰ ° ′ ″ | ″ | m. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | −1 12 00.0 | .0 | −1 09 32.8 | 4.9 | −1 02 21.4 | 9.5 | −0 50 54.9 | 13.3 | −0 36 00.0 | 16.3 | −0 18 38.2 | 18.2 | 60 |
| 1 | 11 59.9 | .1 | 09 27.9 | 5.0 | 02 11.9 | 9.5 | 50 41.6 | 13.4 | 35 43.7 | 16.4 | 18 20.0 | 18.2 | 59 |
| 2 | 11 59.8 | .1 | 09 22.9 | 5.0 | 02 02.4 | 9.6 | 50 28.2 | 13.5 | 35 27.3 | 16.4 | 18 01.8 | 18.3 | 58 |
| 3 | 11 59.6 | .3 | 09 17.9 | 5.2 | 01 52.8 | 9.7 | 50 14.7 | 13.5 | 35 10.9 | 16.4 | 17 43.5 | 18.3 | 57 |
| 4 | 11 59.3 | .4 | 09 12.7 | 5.3 | 01 43.1 | 9.7 | 50 01.2 | 13.6 | 34 54.5 | 16.4 | 17 25.2 | 18.3 | 56 |
| 5 | −1 11 58.9 | .4 | −1 09 07.4 | 5.3 | −1 01 33.4 | 9.8 | −0 49 47.6 | 13.7 | −0 34 38.1 | 16.5 | −0 17 06.9 | 18.3 | 55 |
| 6 | 11 58.5 | .5 | 09 02.1 | 5.4 | 01 23.6 | 9.9 | 49 33.9 | 13.7 | 34 21.6 | 16.6 | 16 48.6 | 18.3 | 54 |
| 7 | 11 58.0 | .6 | 08 56.7 | 5.4 | 01 13.7 | 10.0 | 49 20.2 | 13.7 | 34 05.0 | 16.6 | 16 30.3 | 18.3 | 53 |
| 8 | 11 57.4 | .7 | 08 51.3 | 5.5 | 01 03.7 | 10.0 | 49 06.5 | 13.8 | 33 48.4 | 16.7 | 16 11.9 | 18.4 | 52 |
| 9 | 11 56.7 | .8 | 08 45.8 | 5.6 | 00 53.7 | 10.1 | 48 52.7 | 13.9 | 33 31.7 | 16.7 | 15 53.5 | 18.4 | 51 |
| 10 | −1 11 55.9 | .9 | −1 08 40.2 | 5.8 | −1 00 43.6 | 10.2 | −0 48 38.8 | 14.0 | −0 33 15.0 | 16.8 | −0 15 35.1 | 18.4 | 50 |
| 11 | 11 55.0 | .9 | 08 34.4 | 5.8 | 00 33.4 | 10.2 | 48 24.8 | 14.0 | 32 58.2 | 16.8 | 15 16.7 | 18.4 | 49 |
| 12 | 11 54.1 | 1.0 | 08 28.6 | 5.9 | 00 23.2 | 10.3 | 48 10.8 | 14.0 | 32 41.4 | 16.8 | 14 58.3 | 18.4 | 48 |
| 13 | 11 53.1 | 1.1 | 08 22.7 | 5.9 | 00 12.9 | 10.3 | 47 56.8 | 14.1 | 32 24.6 | 16.8 | 14 39.9 | 18.4 | 47 |
| 14 | 11 52.0 | 1.2 | 08 16.8 | 6.0 | 00 02.6 | 10.5 | 47 42.7 | 14.1 | 32 07.8 | 16.9 | 14 21.5 | 18.4 | 46 |
| 15 | −1 11 50.8 | 1.3 | −1 08 10.8 | 6.1 | −0 59 52.1 | 10.5 | −0 47 28.6 | 14.2 | −0 31 50.9 | 16.9 | −0 14 03.0 | 18.5 | 45 |
| 16 | 11 49.5 | 1.4 | 08 04.7 | 6.2 | 59 41.6 | 10.6 | 47 14.4 | 14.2 | 31 34.0 | 16.9 | 13 44.5 | 18.5 | 44 |
| 17 | 11 48.1 | 1.4 | 07 58.5 | 6.2 | 59 31.0 | 10.6 | 47 00.2 | 14.3 | 31 27.1 | 17.0 | 13 26.0 | 18.5 | 43 |
| 18 | 11 46.7 | 1.5 | 07 52.3 | 6.3 | 59 20.4 | 10.7 | 46 45.9 | 14.4 | 31 10.1 | 17.1 | 13 07.5 | 18.5 | 42 |
| 19 | 11 45.2 | 1.6 | 07 46.0 | 6.4 | 59 09.7 | 10.8 | 46 31.5 | 14.4 | 30 53.0 | 17.1 | 12 48.9 | 18.6 | 41 |
| 20 | −1 11 43.6 | 1.7 | −1 07 39.6 | 6.5 | −0 58 58.9 | 10.9 | −0 46 17.1 | 14.5 | −0 30 36.0 | 17.1 | −0 12 30.3 | 18.6 | 40 |
| 21 | 11 41.9 | 1.8 | 07 33.1 | 6.6 | 58 48.0 | 10.9 | 46 02.6 | 14.5 | 30 18.9 | 17.2 | 12 11.7 | 18.6 | 39 |
| 22 | 11 40.1 | 1.8 | 07 26.5 | 6.6 | 58 37.1 | 10.9 | 45 48.1 | 14.6 | 30 01.7 | 17.2 | 11 53.1 | 18.6 | 38 |
| 23 | 11 38.3 | 2.0 | 07 19.9 | 6.8 | 58 26.2 | 11.1 | 45 33.5 | 14.6 | 29 44.5 | 17.2 | 11 34.5 | 18.6 | 37 |
| 24 | 11 36.3 | 2.0 | 07 13.1 | 6.8 | 58 15.1 | 11.1 | 45 18.9 | 14.7 | 29 17.3 | 17.3 | 11 15.9 | 18.6 | 36 |
| 25 | −1 11 34.3 | 2.1 | −1 07 06.3 | 6.8 | −0 58 04.0 | 11.2 | −0 45 04.2 | 14.8 | −0 29 00.1 | 17.3 | −0 10 57.2 | 18.7 | 35 |
| 26 | 11 32.2 | 2.2 | 06 59.5 | 7.0 | 57 52.8 | 11.2 | 44 49.4 | 14.8 | 28 42.8 | 17.3 | 10 38.6 | 18.6 | 34 |
| 27 | 11 30.0 | 2.2 | 06 52.5 | 7.0 | 57 41.6 | 11.3 | 44 34.6 | 14.8 | 28 25.5 | 17.4 | 10 20.0 | 18.6 | 33 |
| 28 | 11 27.8 | 2.3 | 06 45.5 | 7.1 | 57 30.3 | 11.4 | 44 19.8 | 14.9 | 28 08.2 | 17.4 | 10 01.4 | 18.6 | 32 |
| 29 | 11 25.5 | 2.4 | 06 38.4 | 7.2 | 57 18.9 | 11.4 | 44 04.9 | 14.9 | 27 50.8 | 17.4 | 09 42.7 | 18.7 | 31 |
| 30 | −1 11 23.1 | 2.5 | −1 06 31.2 | 7.2 | −0 57 07.5 | 11.5 | −0 43 50.0 | 15.0 | −0 27 33.4 | 17.4 | −0 09 24.0 | 18.7 | 30 |
| 31 | 11 20.6 | 2.6 | 06 24.0 | 7.3 | 56 56.0 | 11.6 | 43 35.0 | 15.0 | 27 16.0 | 17.5 | 09 05.3 | 18.7 | 29 |
| 32 | 11 18.0 | 2.7 | 06 16.7 | 7.4 | 56 44.4 | 11.6 | 43 20.0 | 15.0 | 26 58.5 | 17.5 | 08 46.6 | 18.7 | 28 |
| 33 | 11 15.3 | 2.7 | 06 09.3 | 7.5 | 56 32.8 | 11.7 | 43 05.0 | 15.1 | 26 41.0 | 17.5 | 08 27.9 | 18.7 | 27 |
| 34 | 11 12.6 | 2.9 | 06 01.8 | 7.6 | 56 21.1 | 11.8 | 42 49.9 | 15.2 | 26 23.5 | 17.6 | 08 09.1 | 18.7 | 26 |
| 35 | −1 11 09.7 | 2.9 | −1 05 54.2 | 7.6 | −0 56 09.3 | 11.8 | −0 42 34.7 | 15.2 | −0 26 05.9 | 17.6 | −0 07 50.4 | 18.7 | 25 |
| 36 | 11 06.8 | 3.0 | 05 46.6 | 7.7 | 55 57.5 | 11.9 | 42 19.5 | 15.3 | 25 48.3 | 17.6 | 07 31.7 | 18.7 | 24 |
| 37 | 11 03.8 | 3.0 | 05 38.9 | 7.8 | 55 45.6 | 12.0 | 42 04.2 | 15.3 | 25 30.7 | 17.6 | 07 12.9 | 18.7 | 23 |
| 38 | 11 00.8 | 3.2 | 05 31.1 | 7.8 | 55 33.6 | 12.0 | 41 48.9 | 15.3 | 25 13.1 | 17.7 | 06 54.1 | 18.8 | 22 |
| 39 | 10 57.6 | 3.2 | 05 23.3 | 8.0 | 55 21.6 | 12.1 | 41 33.6 | 15.4 | 24 55.4 | 17.7 | 06 35.3 | 18.8 | 21 |
| 40 | −1 10 54.4 | 3.3 | −1 05 15.3 | 8.0 | −0 55 09.5 | 12.1 | −0 41 18.2 | 15.5 | −0 24 37.7 | 17.7 | −0 06 16.6 | 18.7 | 20 |
| 41 | 10 51.1 | 3.4 | 05 07.3 | 8.0 | 54 57.4 | 12.2 | 41 02.7 | 15.5 | 24 20.0 | 17.7 | 05 57.8 | 18.8 | 19 |
| 42 | 10 47.7 | 3.5 | 04 59.3 | 8.2 | 54 45.2 | 12.3 | 40 47.2 | 15.6 | 24 02.2 | 17.8 | 05 39.0 | 18.8 | 18 |
| 43 | 10 44.2 | 3.5 | 04 51.1 | 8.2 | 54 32.9 | 12.3 | 40 31.6 | 15.6 | 23 44.4 | 17.8 | 05 20.2 | 18.8 | 17 |
| 44 | 10 40.7 | 3.7 | 04 42.9 | 8.3 | 54 20.6 | 12.4 | 40 16.0 | 15.7 | 23 26.6 | 17.8 | 05 01.4 | 18.8 | 16 |
| 45 | −1 10 37.0 | 3.7 | −1 04 34.6 | 8.4 | −0 54 08.2 | 12.5 | −0 40 00.3 | 15.7 | −0 23 08.8 | 17.8 | −0 04 42.6 | 18.8 | 15 |
| 46 | 10 33.3 | 3.8 | 04 26.2 | 8.4 | 53 55.7 | 12.5 | 39 44.6 | 15.7 | 22 50.9 | 17.9 | 04 23.8 | 18.8 | 14 |
| 47 | 10 29.5 | 3.9 | 04 17.8 | 8.5 | 53 43.2 | 12.6 | 39 28.9 | 15.8 | 22 33.0 | 17.9 | 04 05.0 | 18.8 | 13 |
| 48 | 10 25.6 | 3.9 | 04 09.3 | 8.6 | 53 30.6 | 12.6 | 39 13.1 | 15.8 | 22 15.1 | 17.9 | 03 46.2 | 18.8 | 12 |
| 49 | 10 21.7 | 4.1 | 04 00.7 | 8.7 | 53 18.0 | 12.7 | 38 57.3 | 15.9 | 21 57.2 | 18.0 | 03 27.4 | 18.9 | 11 |
| 50 | −1 10 17.6 | 4.1 | −1 03 52.0 | 8.7 | −0 53 05.3 | 12.8 | −0 38 41.4 | 15.9 | −0 21 39.2 | 18.0 | −0 03 08.5 | 18.8 | 10 |
| 51 | 10 13.5 | 4.2 | 03 43.3 | 8.8 | 52 52.5 | 12.8 | 38 25.5 | 16.0 | 21 21.2 | 18.0 | 02 49.7 | 18.8 | 9 |
| 52 | 10 09.3 | 4.3 | 03 34.5 | 8.9 | 52 39.7 | 12.9 | 38 09.5 | 16.0 | 21 03.2 | 18.0 | 02 30.9 | 18.9 | 8 |
| 53 | 10 05.0 | 4.3 | 03 25.6 | 9.0 | 52 26.8 | 13.0 | 37 53.5 | 16.1 | 20 45.2 | 18.1 | 02 12.0 | 18.8 | 7 |
| 54 | 10 00.7 | 4.5 | 03 16.6 | 9.0 | 52 13.8 | 13.0 | 37 37.4 | 16.1 | 20 27.1 | 18.1 | 01 53.2 | 18.8 | 6 |
| 55 | −1 09 56.2 | 4.5 | −1 03 07.6 | 9.0 | −0 52 00.8 | 13.0 | −0 37 21.3 | 16.2 | −0 20 09.0 | 18.1 | −0 01 34.4 | 18.9 | 5 |
| 56 | 09 51.7 | 4.6 | 02 58.6 | 9.2 | 51 47.8 | 13.1 | 37 05.1 | 16.2 | 19 50.9 | 18.1 | 01 15.5 | 18.8 | 4 |
| 57 | 09 47.1 | 4.7 | 02 49.4 | 9.2 | 51 34.7 | 13.2 | 36 48.9 | 16.3 | 19 32.8 | 18.2 | 00 56.7 | 18.9 | 3 |
| 58 | 09 42.4 | 4.7 | 02 40.2 | 9.4 | 51 21.5 | 13.3 | 36 32.6 | 16.3 | 19 14.6 | 18.2 | 00 37.8 | 18.9 | 2 |
| 59 | 09 37.7 | 4.9 | 02 30.8 | 9.4 | 51 08.2 | 13.3 | 36 16.3 | 16.3 | 18 56.4 | 18.2 | 00 18.9 | 18.9 | 1 |
| 60 | −1 09 32.8 | | −1 02 21.4 | | −0 50 54.9 | | −0 36 00.0 | | −0 18 38.2 | | −0 00 00.0 | | 0 |

| m. | 11ʰ | 10ʰ | 9ʰ | 8ʰ | 7ʰ | 6ʰ | m. |
|---|---|---|---|---|---|---|---|

Change the sign to + when the argument is found at the bottom.

### For finding the Latitude of a place by Altitudes of Polaris.

[B=the 2d correction.  This correction is always additive.]

| Star's hour angle | 10° | 15° | 16° | 17° | 18° | 19° | 20° | 21° | 22° | 23° | Star's hour angle |
|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | h. m. |
| 0 00 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 12 00 |
| 10 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 11 50 |
| 20 | 0.1 .1 | 0.1 .1 | 0.1 .1 | 0.1 .1 | 0.1 .1 | 0.1 .1 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 40 |
| 30 | 0.2 .1 | 0.2 .1 | 0.2 .2 | 0.2 .2 | 0.2 .2 | 0.2 .3 | 0.3 .2 | 0.3 .2 | 0.3 .2 | 0.3 .3 | 30 |
| 40 | 0.3 .1 | 0.3 .2 | 0.4 .2 | 0.4 .2 | 0.4 .3 | 0.5 .3 | 0.5 .3 | 0.5 .3 | 0.6 .3 | 0.6 .3 | 20 |
| 50 | 0.4 .1 | 0.5 .3 | 0.6 .3 | 0.6 .3 | 0.7 .3 | 0.8 .3 | 0.8 .3 | 0.8 .3 | 0.9 .3 | 0.9 .4 | 10 |
| 1 00 | 0.5 .2 | 0.8 .3 | 0.9 .3 | 0.9 .3 | 1.0 .3 | 1.1 .3 | 1.1 .3 | 1.1 .3 | 1.2 .3 | 1.3 .4 | 00 |
| 10 | 0.7 .2 | 1.1 .3 | 1.2 .3 | 1.2 .4 | 1.3 .4 | 1.4 .4 | 1.4 .5 | 1.5 .5 | 1.6 .5 | 1.7 .5 | 10 50 |
| 20 | 0.9 .2 | 1.4 .4 | 1.5 .3 | 1.6 .4 | 1.7 .4 | 1.8 .5 | 1.9 .5 | 2.0 .5 | 2.1 .6 | 2.2 .6 | 40 |
| 30 | 1.1 .3 | 1.8 .4 | 1.8 .5 | 2.0 .4 | 2.1 .4 | 2.3 .5 | 2.4 .5 | 2.5 .6 | 2.7 .5 | 2.8 .6 | 30 |
| 40 | 1.4 .3 | 2.2 .4 | 2.3 .5 | 2.4 .5 | 2.6 .5 | 2.8 .5 | 2.9 .6 | 3.1 .6 | 3.2 .6 | 3.4 .6 | 20 |
| 50 | 1.7 .3 | 2.6 .4 | 2.8 .4 | 2.9 .5 | 3.1 .5 | 3.3 .6 | 3.5 .6 | 3.7 .7 | 3.8 .7 | 4.0 .7 | 10 |
| 2 00 | 2.0 .3 | 3.0 .5 | 3.2 .5 | 3.4 .5 | 3.6 .6 | 3.9 .6 | 4.1 .7 | 4.4 .6 | 4.5 .7 | 4.7 .7 | 00 |
| 10 | 2.3 .3 | 3.5 .5 | 3.7 .6 | 3.9 .6 | 4.2 .6 | 4.5 .6 | 4.8 .6 | 5.0 .7 | 5.3 .8 | 5.5 .8 | 9 50 |
| 20 | 2.6 .3 | 4.0 .5 | 4.3 .6 | 4.5 .6 | 4.9 .7 | 5.1 .7 | 5.4 .7 | 5.7 .7 | 6.0 .7 | 6.3 .8 | 40 |
| 30 | 2.9 .4 | 4.5 .5 | 4.8 .5 | 5.1 .6 | 5.5 .6 | 5.8 .6 | 6.1 .7 | 6.4 .7 | 6.8 .8 | 7.1 .8 | 30 |
| 40 | 3.3 .3 | 5.0 .5 | 5.3 .6 | 5.7 .6 | 6.1 .6 | 6.4 .7 | 6.8 .7 | 7.2 .7 | 7.5 .7 | 7.9 .8 | 20 |
| 50 | 3.6 .4 | 5.5 .5 | 5.9 .6 | 6.3 .6 | 6.7 .7 | 7.1 .7 | 7.5 .8 | 7.9 .8 | 8.3 .8 | 8.7 .8 | 10 |
| 3 00 | 4.0 .4 | 6.0 .5 | 6.5 .6 | 6.9 .6 | 7.4 .6 | 7.8 .7 | 8.3 .6 | 8.7 .8 | 9.1 .8 | 9.5 .8 | 00 |
| 10 | 4.3 .3 | 6.6 .6 | 7.0 .5 | 7.5 .6 | 8.0 .6 | 8.4 .7 | 8.9 .6 | 9.4 .7 | 9.9 .8 | 10.4 .9 | 8 50 |
| 20 | 4.7 .4 | 7.1 .5 | 7.6 .6 | 8.1 .6 | 8.6 .6 | 9.1 .7 | 9.6 .7 | 10.2 .7 | 10.7 .8 | 11.3 .9 | 40 |
| 30 | 5.0 .3 | 7.6 .5 | 8.2 .5 | 8.6 .5 | 9.2 .6 | 9.8 .7 | 10.4 .8 | 10.9 .7 | 11.5 .8 | 12.1 .8 | 30 |
| 40 | 5.3 .3 | 8.1 .5 | 8.7 .5 | 9.2 .6 | 9.9 .7 | 10.4 .6 | 11.0 .6 | 11.6 .7 | 12.2 .7 | 12.9 .8 | 20 |
| 50 | 5.7 .4 | 8.6 .5 | 9.2 .5 | 9.8 .6 | 10.5 .6 | 11.1 .7 | 11.7 .7 | 12.3 .7 | 13.0 .8 | 13.7 .8 | 10 |
| 4 00 | 6.0 .3 | 9.1 .5 | 9.7 .5 | 10.4 .6 | 11.0 .5 | 11.7 .6 | 12.3 .6 | 13.0 .7 | 13.7 .7 | 14.4 .7 | 00 |
| 10 | 6.3 .3 | 9.6 .5 | 10.2 .5 | 10.9 .5 | 11.6 .5 | 12.2 .5 | 13.0 .6 | 13.6 .6 | 14.3 .6 | 15.0 .6 | 7 50 |
| 20 | 6.6 .3 | 10.0 .4 | 10.7 .5 | 11.3 .4 | 12.1 .5 | 12.8 .6 | 13.6 .6 | 14.3 .7 | 14.9 .6 | 15.7 .7 | 40 |
| 30 | 6.8 .2 | 10.4 .4 | 11.1 .4 | 11.7 .4 | 12.5 .4 | 13.3 .5 | 14.0 .4 | 14.8 .5 | 15.6 .7 | 16.3 .6 | 30 |
| 40 | 7.0 .2 | 10.8 .4 | 11.4 .3 | 12.1 .4 | 13.0 .5 | 13.8 .5 | 14.5 .5 | 15.3 .5 | 16.1 .5 | 16.9 .6 | 20 |
| 50 | 7.3 .2 | 11.1 .3 | 11.8 .4 | 12.5 .4 | 13.4 .4 | 14.2 .4 | 15.0 .5 | 15.8 .5 | 16.6 .5 | 17.5 .6 | 10 |
| 5 00 | 7.5 .2 | 11.4 .3 | 12.1 .3 | 12.9 .4 | 13.7 .3 | 14.5 .3 | 15.4 .4 | 16.2 .4 | 17.1 .5 | 17.9 .4 | 00 |
| 10 | 7.6 .1 | 11.6 .2 | 12.4 .3 | 13.2 .3 | 14.0 .3 | 14.8 .3 | 15.7 .3 | 16.5 .3 | 17.4 .3 | 18.3 .4 | 6 50 |
| 20 | 7.8 .2 | 11.7 .1 | 12.6 .2 | 13.4 .2 | 14.2 .2 | 15.1 .3 | 16.0 .3 | 16.8 .3 | 17.7 .3 | 18.6 .3 | 40 |
| 30 | 7.9 .1 | 11.9 .2 | 12.7 .1 | 13.6 .2 | 14.4 .2 | 15.3 .2 | 16.2 .2 | 17.1 .3 | 18.0 .3 | 18.9 .3 | 30 |
| 40 | 7.9 .0 | 12.0 .1 | 12.9 .2 | 13.7 .1 | 14.6 .2 | 15.5 .2 | 16.4 .2 | 17.3 .2 | 18.1 .1 | 19.0 .1 | 20 |
| 50 | 7.9 .0 | 12.1 .1 | 13.0 .1 | 13.8 .1 | 14.7 .1 | 15.6 .1 | 16.5 .1 | 17.3 .0 | 18.2 .1 | 19.1 .1 | 10 |
| 6 00 | 7.9 .0 | 12.2 .1 | 13.0 .0 | 13.9 .1 | 14.7 .0 | 15.6 .0 | 16.5 .0 | 17.3 .0 | 18.3 .1 | 19.2 .1 | 6 00 |

## TABLE 28C.

[C=the 3d correction.  Hor. Arg., the star's declination.  Vert. Arg., B=the 2d correction.]

| B. | 88° 47′ | | | | 88° 48′ | | | | | | 88° 49′ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | 20″ | 30″ | 40″ | 50″ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 0″ | 10″ | 20″ |
|  | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | +0.2 | +0.1 | +0.1 | +0.0 | 0.0 | −0.0 | −0.1 | −0.1 | −0.2 | −0.2 | −0.3 | −0.4 | −0.4 |
| 20 | 0.4 | 0.3 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
| 30 | 0.6 | 0.5 | 0.3 | 0.1 | 0.0 | 0.1 | 0.3 | 0.5 | 0.6 | 0.7 | 0.8 | 1.1 | 1.2 |
| 40 | 0.8 | 0.6 | 0.4 | 0.2 | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.5 | 1.6 |
| 50 | +1.0 | +0.7 | +0.5 | +0.2 | 0.0 | −0.2 | −0.5 | −0.9 | −1.0 | −1.2 | −1.5 | −1.7 | −2.1 |

NOTE.—Below 15° B is nearly proportional to the altitude.

# TABLE 28B.

### For finding the Latitude of a place by Altitudes of Polaris.

[B=the 2d correction.  This correction is always additive.]

| Star's hour angle. | Star's altitude. | | | | | | | | | | Star's hour angle. |
| | 24° | 25° | 26° | 27° | 28° | 29° | 30° | 31° | 32° | 33° | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | h. m. |
| 0 00 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 0.0 .0 | 12 00 |
| 10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 11 50 |
| 20 | 0.1 .1 | 0.1 .1 | 0.2 .2 | 0.2 .2 | 0.2 .2 | 0.2 .2 | 0.2 .2 | 0.2 .2 | 0.2 .2 | 0.2 .2 | 40 |
| 30 | 0.3 .2 | 0.3 .2 | 0.4 .2 | 0.4 .3 | 0.4 .3 | 0.4 .3 | 0.4 .2 | 0.5 .3 | 0.5 .3 | 0.5 .3 | 30 |
| 40 | 0.6 .3 | 0.6 .3 | 0.7 .3 | 0.7 .3 | 0.7 .4 | 0.7 .4 | 0.8 .4 | 0.8 .3 | 0.8 .4 | 0.9 .4 | 20 |
| 50 | 1.0 .4 | 1.0 .4 | 1.1 .4 | 1.1 .4 | 1.1 .4 | 1.1 .6 | 1.2 .4 | 1.3 .5 | 1.3 .5 | 1.4 .5 | 10 |
| 1 00 | 1.4 .4 | 1.4 .4 | 1.5 .4 | 1.5 .4 | 1.6 .5 | 1.7 .6 | 1.7 .5 | 1.8 .5 | 1.9 .6 | 1.9 .5 | 00 |
| 10 | 1.8 .4 | 1.9 .5 | 2.0 .5 | 2.1 .6 | 2.2 .6 | 2.3 .6 | 2.3 .6 | 2.4 .6 | 2.5 .6 | 2.6 .7 | 10 50 |
| 20 | 2.3 .5 | 2.4 .5 | 2.5 .5 | 2.7 .6 | 2.8 .6 | 2.9 .6 | 3.0 .7 | 3.2 .8 | 3.3 .8 | 3.4 .8 | 40 |
| 30 | 2.9 .6 | 3.1 .7 | 3.2 .7 | 3.4 .7 | 3.5 .7 | 3.6 .7 | 3.8 .8 | 4.0 .8 | 4.1 .8 | 4.3 .9 | 30 |
| 40 | 3.6 .7 | 3.8 .7 | 4.0 .8 | 4.1 .7 | 4.3 .8 | 4.5 .9 | 4.7 .9 | 4.9 .9 | 5.0 .9 | 5.3 1.0 | 20 |
| 50 | 4.3 .7 | 4.5 .8 | 4.7 .7 | 4.9 .8 | 5.1 .8 | 5.3 .8 | 5.6 .9 | 5.8 .9 | 6.0 1.0 | 6.2 .9 | 10 |
| 2 00 | 5.0 .7 | 5.3 .8 | 5.5 .8 | 5.8 .9 | 6.0 .9 | 6.2 .9 | 6.5 .9 | 6.8 1.0 | 7.0 1.0 | 7.3 1.1 | 00 |
| 10 | 5.8 .8 | 6.1 .8 | 6.4 .9 | 6.7 .9 | 7.0 1.0 | 7.2 1.0 | 7.5 1.0 | 7.9 1.1 | 8.2 1.2 | 8.5 1.2 | 9 50 |
| 20 | 6.6 .8 | 7.0 .9 | 7.3 .9 | 7.6 .9 | 7.9 .9 | 8.3 1.1 | 8.6 1.1 | 8.9 1.0 | 9.3 1.1 | 9.6 1.1 | 40 |
| 30 | 7.5 .9 | 7.9 .9 | 8.2 .9 | 8.5 .9 | 8.9 1.0 | 9.3 1.0 | 9.6 1.0 | 10.0 1.1 | 10.4 1.1 | 10.8 1.2 | 30 |
| 40 | 8.3 .8 | 8.7 .8 | 9.1 .9 | 9.5 1.0 | 10.0 1.1 | 10.4 1.1 | 10.8 1.2 | 11.2 1.2 | 11.6 1.3 | 12.0 1.2 | 20 |
| 50 | 9.2 .9 | 9.6 .9 | 10.0 1.0 | 10.5 1.0 | 11.0 1.0 | 11.4 1.0 | 11.9 1.1 | 12.4 1.2 | 12.9 1.3 | 13.3 1.3 | 10 |
| 3 00 | 10.0 .8 | 10.5 .9 | 11.0 1.0 | 11.5 1.0 | 12.0 1.0 | 12.5 1.1 | 13.0 1.1 | 13.6 1.2 | 14.1 1.2 | 14.6 1.3 | 00 |
| 10 | 10.9 .9 | 11.4 .9 | 12.0 1.0 | 12.5 1.0 | 13.0 1.0 | 13.6 1.1 | 14.2 1.2 | 14.7 1.1 | 15.4 1.3 | 16.0 1.4 | 8 50 |
| 20 | 11.8 .9 | 12.4 1.0 | 13.0 1.0 | 13.5 1.0 | 14.1 1.1 | 14.7 1.1 | 15.3 1.1 | 15.9 1.2 | 16.6 1.2 | 17.3 1.3 | 40 |
| 30 | 12.6 .8 | 13.3 .9 | 13.9 .9 | 14.5 1.0 | 15.1 1.0 | 15.8 1.1 | 16.4 1.1 | 17.1 1.2 | 17.8 1.2 | 18.5 1.2 | 30 |
| 40 | 13.5 .8 | 14.2 .9 | 14.8 .9 | 15.5 1.0 | 16.1 1.0 | 16.8 1.0 | 17.5 1.1 | 18.2 1.1 | 19.0 1.2 | 19.7 1.2 | 20 |
| 50 | 14.3 .8 | 15.0 .8 | 15.7 .9 | 16.4 .9 | 17.1 1.0 | 17.8 1.0 | 18.5 1.0 | 19.4 1.2 | 20.1 1.1 | 20.9 1.2 | 10 |
| 4 00 | 15.1 .8 | 15.8 .8 | 16.5 .8 | 17.3 .9 | 18.1 1.0 | 18.8 1.0 | 19.6 1.1 | 20.4 1.0 | 21.2 1.1 | 22.0 1.1 | 00 |
| 10 | 15.9 .8 | 16.6 .8 | 17.3 .8 | 18.1 .8 | 19.0 .9 | 19.7 .9 | 20.6 1.0 | 21.4 1.0 | 22.3 1.1 | 23.1 1.1 | 7 50 |
| 20 | 16.6 .7 | 17.3 .7 | 18.1 .8 | 19.0 .9 | 19.8 .8 | 20.6 .9 | 21.5 .9 | 22.4 1.0 | 23.2 .9 | 24.1 1.0 | 40 |
| 30 | 17.2 .6 | 18.0 .7 | 18.8 .7 | 19.7 .7 | 20.5 .7 | 21.4 .8 | 22.3 .8 | 23.2 .8 | 24.1 .9 | 25.1 1.0 | 30 |
| 40 | 17.8 .6 | 18.6 .6 | 19.5 .7 | 20.3 .6 | 21.2 .7 | 22.1 .7 | 23.0 .7 | 24.0 .8 | 24.9 .8 | 25.9 .8 | 20 |
| 50 | 18.3 .5 | 19.2 .6 | 20.1 .6 | 21.0 .7 | 21.9 .7 | 22.8 .7 | 23.7 .7 | 24.6 .6 | 25.7 .8 | 26.7 .8 | 10 |
| 5 00 | 18.8 .5 | 19.7 .5 | 20.6 .5 | 21.5 .5 | 22.4 .5 | 23.4 .6 | 24.4 .7 | 25.3 .7 | 26.4 .7 | 27.4 .7 | 00 |
| 10 | 19.2 .4 | 20.1 .4 | 21.1 .5 | 22.0 .5 | 22.9 .5 | 23.9 .5 | 24.9 .5 | 25.8 .5 | 27.0 .6 | 28.0 .6 | 6 50 |
| 20 | 19.5 .3 | 20.5 .4 | 21.4 .3 | 22.4 .4 | 23.3 .4 | 24.3 .4 | 25.4 .5 | 26.2 .4 | 27.4 .4 | 28.5 .5 | 40 |
| 30 | 19.8 .3 | 20.7 .2 | 21.7 .3 | 22.6 .2 | 23.6 .3 | 24.6 .3 | 25.7 .3 | 26.6 .4 | 27.8 .4 | 28.8 .3 | 30 |
| 40 | 20.0 .2 | 20.9 .2 | 21.9 .2 | 22.8 .2 | 23.9 .3 | 24.9 .3 | 25.9 .2 | 26.9 .3 | 28.0 .2 | 29.1 .3 | 20 |
| 50 | 20.1 .1 | 21.0 .1 | 22.0 .1 | 23.0 .2 | 24.0 .1 | 25.0 .1 | 26.0 .1 | 27.0 .1 | 28.2 .2 | 29.3 .2 | 10 |
| 6 00 | 20.2 .1 | 21.1 .1 | 22.0 .0 | 23.1 .1 | 24.1 .1 | 25.1 .1 | 26.1 .1 | 27.1 .1 | 28.3 .1 | 29.4 .1 | 6 00 |

# TABLE 28C.

[C=the 3d correction.  Hor. Arg., the star's declination.  Vert. Arg., B=the 2d correction.]

| B. | 88° 47′ | | | | 88° 48′ | | | | | | 88° 49′ | | |
| | 20″ | 30″ | 40″ | 50″ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 0″ | 10″ | 20″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | +0.2 | +0.1 | +0.1 | +0.0 | 0.0 | −0.0 | −0.1 | −0.1 | −0.2 | −0.2 | −0.3 | −0.4 | −0.4 |
| 20 | 0.4 | 0.3 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
| 30 | 0.6 | 0.5 | 0.3 | 0.1 | 0.0 | 0.1 | 0.3 | 0.5 | 0.6 | 0.7 | 0.8 | 1.1 | 1.2 |
| 40 | 0.8 | 0.6 | 0.4 | 0.2 | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.5 | 1.6 |
| 50 | +1.0 | +0.7 | +0.5 | +0.2 | 0.0 | −0.2 | −0.5 | −0.7 | −1.0 | −1.2 | −1.5 | −1.7 | −2.1 |

### For finding the Latitude of a place by Altitudes of Polaris.

[B = the 2d correction.  This correction is always additive.]

| Star's hour angle. | 34° | 35° | 36° | 37° | 38° | 39° | 40° | 41° | 42° | 43° | Star's hour angle. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| h. m. | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | h. m. |
| 0 00 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 12 00 |
| 10 | 0.1 .1 | 0.1 .1 | 0.1 .1 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 11 50 |
| 20 | 0.2 .3 | 0.2 .3 | 0.2 .3 | 0.3 .3 | 0.3 .3 | 0.3 .3 | 0.3 .3 | 0.3 .4 | 0.3 .4 | 0.3 .4 | 40 |
| 30 | 0.5 .4 | 0.5 .5 | 0.5 .5 | 0.6 .4 | 0.6 .5 | 0.6 .5 | 0.6 .5 | 0.7 .5 | 0.7 .5 | 0.7 .6 | 30 |
| 40 | 0.9 .6 | 1.0 .5 | 1.0 .6 | 1.0 .6 | 1.1 .5 | 1.1 .6 | 1.1 .7 | 1.2 .7 | 1.2 .7 | 1.3 .6 | 20 |
| 50 | 1.5 .5 | 1.5 .6 | 1.5 .7 | 1.6 .7 | 1.6 .7 | 1.7 .7 | 1.8 .7 | 1.9 .8 | 1.9 .9 | 1.9 .9 | 10 |
| 1 00 | 2.0 .8 | 2.1 .7 | 2.2 .8 | 2.3 .8 | 2.3 .9 | 2.4 .9 | 2.5 .9 | 2.7 .9 | 2.8 .9 | 2.8 1.0 | 00 |
| 10 | 2.8 .8 | 2.8 .9 | 3.0 .8 | 3.1 .9 | 3.2 .9 | 3.3 1.0 | 3.4 1.1 | 3.6 1.0 | 3.7 1.1 | 3.8 1.1 | 10 50 |
| 20 | 3.6 .9 | 3.7 .9 | 3.8 1.0 | 4.0 1.0 | 4.1 1.1 | 4.3 1.0 | 4.5 1.1 | 4.6 1.2 | 4.8 1.2 | 4.9 1.3 | 40 |
| 30 | 4.5 1.0 | 4.6 1.0 | 4.8 1.0 | 5.0 1.1 | 5.2 1.1 | 5.3 1.3 | 5.6 1.2 | 5.8 1.2 | 6.0 1.3 | 6.2 1.3 | 30 |
| 40 | 5.4 1.1 | 5.6 1.1 | 5.8 1.2 | 6.1 1.2 | 6.3 1.2 | 6.6 1.2 | 6.8 1.3 | 7.0 1.3 | 7.3 1.4 | 7.5 1.5 | 20 |
| 50 | 6.5 1.1 | 6.7 1.2 | 7.0 1.2 | 7.3 1.2 | 7.5 1.3 | 7.8 1.4 | 8.1 1.4 | 8.3 1.5 | 8.7 1.5 | 9.0 1.5 | 10 |
| 2 00 | 7.6 1.2 | 7.9 1.3 | 8.2 1.3 | 8.5 1.3 | 8.8 1.4 | 9.2 1.4 | 9.5 1.4 | 9.8 1.5 | 10.2 1.5 | 10.5 1.6 | 00 |
| 10 | 8.8 1.2 | 9.2 1.3 | 9.5 1.3 | 9.8 1.4 | 10.2 1.5 | 10.6 1.5 | 10.9 1.4 | 11.3 1.7 | 11.7 1.7 | 12.1 1.8 | 9 50 |
| 20 | 10.0 1.3 | 10.5 1.3 | 10.8 1.3 | 11.2 1.4 | 11.7 1.4 | 12.1 1.5 | 12.5 1.6 | 13.0 1.6 | 13.4 1.7 | 13.9 1.9 | 40 |
| 30 | 11.3 1.3 | 11.7 1.4 | 12.1 1.5 | 12.6 1.5 | 13.1 1.5 | 13.6 1.5 | 14.1 1.6 | 14.6 1.6 | 15.1 1.7 | 15.6 1.8 | 30 |
| 40 | 12.6 1.3 | 13.1 1.3 | 13.6 1.4 | 14.1 1.5 | 14.6 1.5 | 15.1 1.6 | 15.7 1.6 | 16.2 1.8 | 16.8 1.7 | 17.4 1.9 | 20 |
| 50 | 13.9 1.3 | 14.4 1.5 | 15.0 1.4 | 15.6 1.4 | 16.1 1.6 | 16.7 1.6 | 17.3 1.7 | 18.0 1.7 | 18.5 1.8 | 19.3 1.8 | 10 |
| 3 00 | 15.2 1.4 | 15.9 1.4 | 16.4 1.5 | 17.0 1.5 | 17.7 1.5 | 18.3 1.6 | 19.0 1.7 | 19.7 1.7 | 20.3 1.8 | 21.1 1.8 | 00 |
| 10 | 16.6 1.3 | 17.3 1.3 | 17.9 1.4 | 18.5 1.5 | 19.2 1.5 | 19.9 1.6 | 20.7 1.6 | 21.4 1.7 | 22.1 1.8 | 22.9 1.9 | 8 50 |
| 20 | 17.9 1.3 | 18.6 1.3 | 19.3 1.4 | 20.0 1.5 | 20.7 1.6 | 21.5 1.6 | 22.3 1.6 | 23.1 1.6 | 23.9 1.7 | 24.8 1.7 | 40 |
| 30 | 19.2 1.3 | 19.9 1.3 | 20.7 1.3 | 21.5 1.3 | 22.3 1.4 | 23.1 1.5 | 23.9 1.5 | 24.7 1.7 | 25.6 1.7 | 26.5 1.8 | 30 |
| 40 | 20.5 1.2 | 21.2 1.3 | 22.0 1.4 | 22.8 1.4 | 23.7 1.4 | 24.6 1.5 | 25.4 1.6 | 26.4 1.5 | 27.3 1.7 | 28.3 1.7 | 20 |
| 50 | 21.7 1.1 | 22.5 1.2 | 23.4 1.2 | 24.2 1.4 | 25.1 1.4 | 26.1 1.4 | 27.0 1.4 | 27.9 1.6 | 29.0 1.5 | 30.0 1.7 | 10 |
| 4 00 | 22.8 1.2 | 23.7 1.2 | 24.6 1.2 | 25.6 1.2 | 26.5 1.3 | 27.5 1.3 | 28.4 1.5 | 29.5 1.4 | 30.5 1.6 | 31.7 1.5 | 00 |
| 10 | 24.0 1.0 | 24.9 1.1 | 25.8 1.2 | 26.8 1.2 | 27.8 1.2 | 28.8 1.3 | 29.9 1.3 | 30.9 1.4 | 32.1 1.4 | 33.2 1.5 | 7 50 |
| 20 | 25.0 1.1 | 26.0 1.1 | 27.0 1.0 | 28.0 1.1 | 29.0 1.1 | 30.1 1.2 | 31.2 1.2 | 32.3 1.2 | 33.5 1.2 | 34.7 1.3 | 40 |
| 30 | 26.1 .9 | 27.1 .9 | 28.0 1.0 | 29.1 1.0 | 30.1 1.1 | 31.3 1.0 | 32.4 1.1 | 33.5 1.2 | 34.7 1.3 | 36.0 1.3 | 30 |
| 40 | 27.0 .8 | 27.9 .9 | 29.0 .9 | 30.1 .9 | 31.2 1.0 | 32.3 1.0 | 33.5 .9 | 34.7 1.1 | 36.0 1.0 | 37.3 1.1 | 20 |
| 50 | 27.8 .6 | 28.8 .8 | 29.9 .8 | 31.0 .8 | 32.2 .8 | 33.3 .9 | 34.4 .9 | 35.8 .9 | 37.0 1.0 | 38.4 1.0 | 10 |
| 5 00 | 28.4 .7 | 29.6 .6 | 30.7 .6 | 31.8 .7 | 33.0 .7 | 34.2 .7 | 35.3 .8 | 36.7 .8 | 38.0 .8 | 39.4 .8 | 00 |
| 10 | 29.1 .5 | 30.2 .5 | 31.3 .5 | 32.5 .5 | 33.7 .6 | 34.9 .7 | 36.1 .7 | 37.5 .7 | 38.8 .7 | 40.2 .7 | 6 50 |
| 20 | 29.6 .4 | 30.7 .5 | 31.8 .5 | 33.0 .5 | 34.3 .4 | 35.6 .4 | 36.8 .5 | 38.2 .4 | 39.5 .5 | 40.9 .6 | 40 |
| 30 | 30.0 .3 | 31.1 .4 | 32.3 .3 | 33.5 .4 | 34.7 .4 | 36.0 .4 | 37.3 .3 | 38.6 .4 | 40.0 .4 | 41.5 .4 | 30 |
| 40 | 30.3 .2 | 31.4 .2 | 32.6 .2 | 33.9 .1 | 35.1 .1 | 36.4 .1 | 37.6 .2 | 39.0 .3 | 40.4 .3 | 41.9 .2 | 20 |
| 50 | 30.5 .0 | 31.6 .1 | 32.8 .1 | 34.0 .1 | 35.2 .1 | 36.5 .1 | 37.8 .1 | 39.3 .1 | 40.7 .1 | 42.1 .1 | 10 |
| 6 00 | 30.5 | 31.7 | 32.9 | 34.1 | 35.3 | 36.6 | 37.9 | 39.4 | 40.8 | 42.2 | 6 00 |

## TABLE 28C.

[C = the 3d correction.  Hor. Arg., the star's declination.  Vert. Arg., B = the 2d correction.]

| B. | 88° 47' | | | | 88° 48' | | | | | | 88° 49' | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20'' | 30'' | 40'' | 50'' | 0'' | 10'' | 20'' | 30'' | 40'' | 50'' | 0'' | 10'' | 20'' |
| '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | +0.2 | +0.1 | +0.1 | +0.0 | 0.0 | −0.0 | −0.1 | −0.1 | −0.2 | −0.2 | −0.3 | −0.4 | −0.4 |
| 20 | 0.4 | 0.3 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
| 30 | 0.6 | 0.5 | 0.3 | 0.1 | 0.0 | 0.1 | 0.3 | 0.5 | 0.6 | 0.7 | 0.8 | 1.1 | 1.2 |
| 40 | 0.8 | 0.6 | 0.4 | 0.2 | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.5 | 1.6 |
| 50 | +1.0 | +0.7 | +0.5 | +0.2 | 0.0 | −0.2 | −0.5 | −0.7 | −1.0 | −1.2 | −1.5 | −1.7 | −2.1 |

## TABLE 28B.

For finding the Latitude of a place by Altitudes of Polaris.

[B=the 2d correction.  This correction is always additive.]

| Star's hour angle. | 44° | 45° | 46° | 47° | 48° | 49° | 50° | 51° | 52° | Star's hour angle. |
|---|---|---|---|---|---|---|---|---|---|---|
| h.  m. | '' | '' | '' | '' | '' | '' | '' | '' | '' | h.  m. |
| 0 00 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 0.0 .1 | 12 00 |
| 10 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 0.1 .2 | 0.1 .3 | 0.1 .3 | 0.1 .3 | 0.1 .3 | 0.1 .3 | 11 50 |
| 20 | 0.3 .4 | 0.3 .4 | 0.3 .5 | 0.3 .5 | 0.4 .5 | 0.4 .5 | 0.4 .5 | 0.4 .6 | 0.4 .6 | 40 |
| 30 | 0.7 .6 | 0.7 .7 | 0.8 .6 | 0.8 .7 | 0.9 .6 | 0.9 .7 | 0.9 .7 | 1.0 .7 | 1.0 .8 | 30 |
| 40 | 1.3 .7 | 1.4 .7 | 1.4 .8 | 1.5 .8 | 1.5 .8 | 1.6 .8 | 1.6 .9 | 1.7 .9 | 1.8 1.0 | 20 |
| 50 | 2.0 .9 | 2.1 .9 | 2.2 1.0 | 2.3 .9 | 2.3 1.1 | 2.4 1.1 | 2.5 1.1 | 2.6 1.1 | 2.8 1.1 | 10 |
| 1 00 | 2.9 1.1 | 3.0 1.1 | 3.2 1.1 | 3.2 1.2 | 3.4 1.1 | 3.5 1.2 | 3.6 1.3 | 3.7 1.3 | 3.9 1.4 | 00 |
| 10 | 4.0 1.1 | 4.1 1.2 | 4.2 1.3 | 4.4 1.3 | 4.5 1.4 | 4.7 1.4 | 4.9 1.4 | 5.0 1.6 | 5.3 1.5 | 10 50 |
| 20 | 5.1 1.3 | 5.3 1.3 | 5.5 1.4 | 5.7 1.4 | 5.9 1.5 | 6.1 1.5 | 6.3 1.6 | 6.6 1.6 | 6.8 1.7 | 40 |
| 30 | 6.4 1.4 | 6.6 1.5 | 6.9 1.4 | 7.1 1.6 | 7.4 1.6 | 7.6 1.7 | 7.9 1.7 | 8.2 1.8 | 8.5 1.8 | 30 |
| 40 | 7.8 1.5 | 8.1 1.5 | 8.3 1.7 | 8.7 1.7 | 9.0 1.7 | 9.3 1.8 | 9.6 1.9 | 10.0 1.9 | 10.3 2.0 | 20 |
| 50 | 9.3 1.6 | 9.6 1.7 | 10.0 1.7 | 10.4 1.8 | 10.7 1.9 | 11.1 1.9 | 11.5 2.0 | 11.9 2.0 | 12.3 2.2 | 10 |
| 2 00 | 10.9 1.7 | 11.3 1.7 | 11.7 1.8 | 12.2 1.8 | 12.6 1.9 | 13.0 2.0 | 13.5 2.1 | 13.9 2.2 | 14.5 2.2 | 00 |
| 10 | 12.6 1.7 | 13.0 1.9 | 13.5 1.9 | 14.0 2.0 | 14.5 2.0 | 15.0 2.1 | 15.6 2.1 | 16.1 2.3 | 16.7 2.3 | 9 50 |
| 20 | 14.3 1.9 | 14.9 1.9 | 16.0 2.0 | 16.0 2.0 | 16.5 2.1 | 17.1 2.2 | 17.7 2.3 | 18.4 2.3 | 19.0 2.5 | 40 |
| 30 | 16.2 1.9 | 16.8 1.9 | 17.3 2.1 | 18.0 2.0 | 18.6 2.1 | 19.3 2.2 | 20.0 2.3 | 20.7 2.4 | 21.5 2.4 | 30 |
| 40 | 18.1 1.8 | 18.7 2.0 | 19.4 2.0 | 20.0 2.1 | 20.7 2.2 | 21.5 2.2 | 22.3 2.3 | 23.1 2.4 | 23.9 2.5 | 20 |
| 50 | 19.9 2.0 | 20.7 1.9 | 21.4 2.0 | 22.1 2.1 | 22.9 2.2 | 23.7 2.3 | 24.6 2.4 | 25.5 2.4 | 26.4 2.5 | 10 |
| 3 00 | 21.9 1.8 | 22.6 2.0 | 23.4 2.0 | 24.2 2.2 | 25.1 2.2 | 26.0 2.3 | 27.0 2.3 | 27.9 2.5 | 28.9 2.6 | 00 |
| 10 | 23.7 1.9 | 24.6 2.0 | 25.4 2.1 | 26.4 2.1 | 27.3 2.2 | 28.3 2.2 | 29.3 2.4 | 30.4 2.4 | 31.5 2.5 | 8 50 |
| 20 | 25.6 1.9 | 26.6 1.9 | 27.5 2.0 | 28.5 2.0 | 29.5 2.1 | 30.5 2.2 | 31.7 2.2 | 32.8 2.4 | 34.0 2.5 | 40 |
| 30 | 27.5 1.8 | 28.5 1.9 | 29.5 1.9 | 30.5 2.1 | 31.6 2.1 | 32.7 2.2 | 33.9 2.3 | 35.2 2.3 | 36.5 2.3 | 30 |
| 40 | 29.3 1.8 | 30.4 1.8 | 31.4 1.9 | 32.6 1.9 | 33.7 2.0 | 34.9 2.1 | 36.2 2.1 | 37.5 2.3 | 38.9 2.3 | 20 |
| 50 | 31.1 1.6 | 32.2 1.7 | 33.3 1.9 | 34.5 1.9 | 35.7 2.0 | 37.0 2.0 | 38.3 2.1 | 39.8 2.1 | 41.2 2.2 | 10 |
| 4 00 | 32.7 1.6 | 33.9 1.7 | 35.2 1.7 | 36.4 1.8 | 37.7 1.8 | 39.0 2.0 | 40.4 2.1 | 41.9 2.1 | 43.4 2.2 | 00 |
| 10 | 34.3 1.6 | 35.6 1.6 | 36.9 1.6 | 38.2 1.7 | 39.5 1.8 | 41.0 1.8 | 42.5 1.8 | 44.0 1.9 | 45.5 2.1 | 7 50 |
| 20 | 35.9 1.4 | 37.2 1.4 | 38.5 1.5 | 39.9 1.5 | 41.3 1.5 | 42.8 1.6 | 44.3 1.7 | 45.9 1.8 | 47.5 2.0 | 40 |
| 30 | 37.3 1.3 | 38.6 1.3 | 40.0 1.4 | 41.4 1.4 | 42.8 1.6 | 44.4 1.5 | 46.0 1.6 | 47.7 1.6 | 49.4 1.9 | 30 |
| 40 | 38.6 1.2 | 39.9 1.2 | 41.4 1.2 | 42.8 1.3 | 44.4 1.3 | 45.9 1.4 | 47.6 1.4 | 49.3 1.5 | 51.1 1.7 | 20 |
| 50 | 39.8 .9 | 41.1 1.1 | 42.6 1.1 | 44.1 1.2 | 45.7 1.2 | 47.3 1.3 | 49.0 1.3 | 50.8 1.3 | 52.7 1.6 | 10 |
| 5 00 | 40.7 .9 | 42.2 .9 | 43.7 .9 | 45.3 1.0 | 46.9 1.0 | 48.6 1.1 | 50.3 1.2 | 52.1 1.1 | 54.0 1.3 | 00 |
| 10 | 41.6 .8 | 43.1 .8 | 44.6 .8 | 46.3 .8 | 47.9 .8 | 49.7 .8 | 51.5 .9 | 53.2 1.0 | 55.2 1.2 | 6 50 |
| 20 | 42.4 .5 | 43.9 .6 | 45.4 .7 | 47.1 .6 | 48.7 .7 | 50.5 .7 | 52.4 .7 | 54.2 .7 | 56.1 .9 | 40 |
| 30 | 42.9 .4 | 44.5 .4 | 46.1 .4 | 47.7 .4 | 49.4 .5 | 51.2 .5 | 53.1 .5 | 54.9 .6 | 56.9 .8 | 30 |
| 40 | 43.3 .3 | 44.9 .2 | 46.5 .2 | 48.1 .3 | 49.9 .2 | 51.7 .2 | 53.6 .3 | 55.5 .2 | 57.5 .6 | 20 |
| 50 | 43.6 .1 | 45.1 .2 | 46.7 .1 | 48.4 .1 | 50.1 .1 | 51.9 .2 | 53.9 .1 | 55.7 .2 | 57.8 .3 | 10 |
| 6 00 | 43.7 | 45.3 | 46.8 | 48.5 | 50.2 | 52.1 | 54.0 | 55.9 | 57.9 .1 | 6 00 |

## TABLE 28C.

[C=the 3d correction.  Hor. Arg., the star's declination.  Vert. Arg., B=the 2d correction.]

| B. | 88° 47' | | | | 88° 48' | | | | | | 88° 49' | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20'' | 30'' | 40'' | 50'' | 0'' | 10'' | 20'' | 30'' | 40'' | 50'' | 0'' | 10'' | 20'' |
| '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' | '' |
| 30 | +0.6 | +0.5 | +0.3 | +0.1 | 0.0 | −0.1 | −0.3 | −0.5 | −0.6 | −0.7 | −0.8 | −1.1 | −1.2 |
| 40 | 0.9 | 0.6 | 0.4 | 0.2 | 0.0 | 0.2 | 0.4 | 0.6 | 0.9 | 1.2 | 1.2 | 1.4 | 1.6 |
| 50 | 1.0 | 0.7 | 0.5 | 0.2 | 0.0 | 0.2 | 0.5 | 0.7 | 1.0 | 1.2 | 1.5 | 1.7 | 2.0 |
| 60 | 1.2 | 0.9 | 0.6 | 0.2 | 0.0 | 0.2 | 0.6 | 0.9 | 1.2 | 1.5 | 1.8 | 2.1 | 2.5 |
| 70 | 1.5 | ·1.1 | 0.7 | 0.4 | 0.0 | 0.4 | 0.7 | 1.1 | 1.5 | 1.8 | 2.1 | 2.5 | 2.8 |
| 80 | +1.6 | +1.2 | +0.8 | +0.4 | 0.0 | −0.4 | −0.8 | −1.2 | −1.6 | −2.1 | −2.5 | −2.8 | −3.3 |

## For finding the Latitude of a place by Altitudes of Polaris.

[B = the 2d correction.  This correction is always additive.]

Star's altitude.

| Star's hour angle | 53° | 54° | 55° | 56° | 57° | 58° | 59° | 60° | Star's hour angle |
|---|---|---|---|---|---|---|---|---|---|
| h. m. | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | ′ ″ | h. m. |
| 0 00 | 0 0.0 (0.1) | 0 0.0 (0.1) | 0 0.0 (0.1) | 0 0.0 (0.2) | 0 0.0 (0.2) | 0 0.0 (0.2) | 0 0.0 (0.2) | 0 0.0 (0.2) | 12 00 |
| 10 | 0.1 (0.4) | 0.1 (0.4) | 0.1 (0.4) | 0.2 (0.3) | 0.2 (0.3) | 0.2 (0.4) | 0.2 (0.4) | 0.2 (0.4) | 11 50 |
| 20 | 0.5 (0.5) | 0.5 (0.5) | 0.5 (0.6) | 0.5 (0.6) | 0.5 (0.7) | 0.6 (0.6) | 0.6 (0.7) | 0.6 (0.7) | 40 |
| 30 | 1.0 (0.8) | 1.0 (0.8) | 1.1 (0.8) | 1.1 (0.9) | 1.2 (0.9) | 1.2 (1.0) | 1.3 (0.9) | 1.3 (1.0) | 30 |
| 40 | 1.8 (1.0) | 1.8 (1.1) | 1.9 (1.1) | 2.0 (1.1) | 2.1 (1.1) | 2.2 (1.2) | 2.2 (1.3) | 2.3 (1.3) | 20 |
| 50 | 2.8 (1.2) | 2.9 (1.3) | 3.0 (1.3) | 3.1 (1.4) | 3.2 (1.5) | 3.4 (1.5) | 3.5 (1.5) | 3.6 (1.7) | 10 |
| 1 00 | 4.0 (1.4) | 4.2 (1.4) | 4.3 (1.5) | 4.5 (1.6) | 4.7 | 4.9 (1.7) | 5.0 (1.8) | 5.3 (1.8) | 00 |
| 10 | 0 5.4 (1.6) | 0 5.6 (1.7) | 0 5.8 (1.7) | 0 6.1 (1.8) | 0 6.3 (1.9) | 0 6.6 (1.8) | 0 6.8 (2.0) | 0 7.1 (2.0) | 10 50 |
| 20 | 7.0 (1.8) | 7.3 (1.8) | 7.5 (2.0) | 7.9 (1.9) | 8.2 (2.0) | 8.4 (2.2) | 8.8 (2.2) | 9.1 (2.4) | 40 |
| 30 | 8.8 (1.9) | 9.1 (2.0) | 9.5 (2.0) | 9.8 (2.1) | 10.2 (2.3) | 10.6 (2.4) | 11.0 (2.4) | 11.5 (2.5) | 30 |
| 40 | 10.7 (2.1) | 11.1 (2.2) | 11.5 (2.3) | 11.9 (2.4) | 12.5 (2.3) | 13.0 (2.5) | 13.4 (2.6) | 14.0 (2.5) | 20 |
| 50 | 12.8 (2.2) | 13.3 (2.3) | 13.8 (2.3) | 14.3 (2.4) | 14.8 (2.6) | 15.5 (2.6) | 16.0 (2.7) | 16.7 (2.7) | 10 |
| 2 00 | 15.0 (2.3) | 15.6 (2.4) | 16.1 (2.5) | 16.8 (2.5) | 17.4 (2.7) | 18.1 (2.7) | 18.8 (2.9) | 19.6 (3.0) | 00 |
| 10 | 0 17.3 (2.4) | 0 18.0 (2.5) | 0 18.6 (2.7) | 0 19.3 (2.8) | 0 20.1 (2.8) | 0 20.8 (3.0) | 0 21.7 (3.1) | 0 22.6 (3.2) | 9 50 |
| 20 | 19.7 (2.5) | 20.5 (2.6) | 21.3 (2.7) | 22.1 (2.8) | 22.9 (2.9) | 23.8 (3.0) | 24.8 (3.1) | 25.8 (3.3) | 40 |
| 30 | 22.2 (2.6) | 23.1 (2.6) | 24.0 (2.7) | 24.9 (2.8) | 25.8 (3.0) | 26.8 (3.1) | 27.9 (3.2) | 29.1 (3.3) | 30 |
| 40 | 24.8 (2.6) | 25.7 (2.7) | 26.7 (2.8) | 27.7 (2.9) | 28.8 (3.0) | 29.9 (3.1) | 31.1 (3.2) | 32.4 (3.4) | 20 |
| 50 | 27.4 (2.7) | 28.4 (2.7) | 29.5 (2.8) | 30.6 (2.9) | 31.8 (3.0) | 33.0 (3.2) | 34.3 (3.3) | 35.8 (3.4) | 10 |
| 3 00 | 30.1 (2.5) | 31.1 (2.7) | 32.3 (2.8) | 33.5 (3.0) | 34.8 (3.1) | 36.2 (3.2) | 37.6 (3.3) | 39.2 (3.4) | 00 |
| 10 | 0 32.6 (2.6) | 0 33.8 (2.7) | 0 35.1 (2.8) | 0 36.5 (2.9) | 0 37.9 (3.0) | 0 39.4 (3.1) | 0 40.9 (3.3) | 0 42.6 (3.4) | 8 50 |
| 20 | 35.2 (2.6) | 36.5 (2.7) | 37.9 (2.8) | 39.4 (2.8) | 40.9 (2.9) | 42.5 (3.1) | 44.2 (3.2) | 46.0 (3.3) | 40 |
| 30 | 37.8 (2.5) | 39.2 (2.6) | 40.7 (2.6) | 42.2 (2.8) | 43.8 (2.9) | 45.6 (3.0) | 47.4 (3.1) | 49.3 (3.3) | 30 |
| 40 | 40.3 (2.4) | 41.8 (2.5) | 43.3 (2.6) | 45.0 (2.7) | 46.7 (2.9) | 48.6 (2.9) | 50.5 (3.0) | 52.6 (3.1) | 20 |
| 50 | 42.7 (2.3) | 44.3 (2.4) | 45.9 (2.5) | 47.7 (2.6) | 49.6 (2.6) | 51.5 (2.8) | 53.5 (2.9) | 55.7 (3.1) | 10 |
| 4 00 | 45.0 (2.2) | 46.7 (2.3) | 48.4 (2.4) | 50.3 (2.5) | 52.2 (2.6) | 54.3 (2.6) | 56.4 (2.8) | 58.8 (2.8) | 00 |
| 10 | 0 47.2 (2.1) | 0 49.0 (2.1) | 0 50.8 (2.3) | 0 52.8 (2.3) | 0 54.8 (2.4) | 0 56.9 (2.5) | 0 59.2 (2.7) | 1 1.6 (2.8) | 7 50 |
| 20 | 49.3 (2.0) | 51.1 (2.0) | 53.1 (2.1) | 55.1 (2.2) | 57.2 (2.3) | 59.4 (2.4) | 1 1.9 (2.4) | 1 4.4 (2.5) | 40 |
| 30 | 51.3 (1.8) | 53.1 (1.9) | 55.2 (1.9) | 57.3 (1.9) | 59.5 (2.1) | 1 1.8 (2.1) | 1 4.3 (2.2) | 1 6.9 (2.3) | 30 |
| 40 | 53.1 (1.5) | 55.0 (1.6) | 57.1 (1.7) | 59.2 (1.8) | 1 1.6 (1.8) | 1 3.9 (2.0) | 1 6.5 (2.0) | 1 9.2 (2.1) | 20 |
| 50 | 54.6 (1.5) | 56.6 (1.5) | 58.8 (1.5) | 1 1.0 (1.6) | 1 3.4 (1.6) | 1 5.9 (1.7) | 1 8.5 (1.8) | 1 11.3 (1.8) | 10 |
| 5 00 | 56.1 (1.2) | 58.1 (1.3) | 1 0.3 (1.3) | 1 2.6 (1.3) | 1 5.0 (1.4) | 1 7.6 (1.4) | 1 10.3 (1.5) | 1 13.1 (1.6) | 00 |
| 10 | 0 57.3 (0.9) | 0 59.4 (1.0) | 1 1.6 (1.1) | 1 3.9 (1.1) | 1 6.4 (1.2) | 1 9.0 (1.2) | 1 11.8 (1.3) | 1 14.7 (1.4) | 6 50 |
| 20 | 58.2 (0.8) | 1 0.4 (0.8) | 1 2.7 (0.8) | 1 5.0 (0.9) | 1 7.6 (0.9) | 1 10.2 (1.0) | 1 13.1 (0.9) | 1 16.1 (0.9) | 40 |
| 30 | 59.0 (0.6) | 1 1.2 (0.6) | 1 3.5 (0.7) | 1 5.9 (0.7) | 1 8.5 (0.7) | 1 11.2 (0.6) | 1 14.0 (0.8) | 1 17.0 (0.8) | 30 |
| 40 | 59.6 (0.3) | 1 1.8 (0.3) | 1 4.2 (0.3) | 1 6.6 (0.4) | 1 9.2 (0.4) | 1 11.8 (0.4) | 1 14.8 (0.4) | 1 17.8 (0.4) | 20 |
| 50 | 59.9 (0.1) | 1 2.1 (0.2) | 1 4.5 (0.2) | 1 7.0 (0.1) | 1 9.6 (0.1) | 1 12.2 (0.2) | 1 15.2 (0.2) | 1 18.2 (0.2) | 10 |
| 6 00 | 1 0.0 | 1 2.3 | 1 4.7 | 1 7.1 | 1 9.7 | 1 12.4 | 1 15.4 | 1 18.4 | 6 00 |

## TABLE 28C.

[C = the 3d correction.  Hor. Arg., the star's declination.  Vert. Arg., B = the 2d correction.]

| B. | 88° 47′ | | | | 88° 48′ | | | | | | 88° 49′ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20″ | 30″ | 40″ | 50″ | 0″ | 10″ | 20″ | 30″ | 40″ | 50″ | 0″ | 10″ | 20″ |
| ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 30 | +0.6 | +0.5 | +0.3 | +0.1 | 0.0 | −0.1 | −0.3 | −0.5 | −0.6 | −0.7 | −0.8 | −1.1 | −1.2 |
| 40 | 0.9 | 0.6 | 0.4 | 0.2 | 0.0 | 0.2 | 0.4 | 0.6 | 0.9 | 1.0 | 1.2 | 1.4 | 1.6 |
| 50 | 1.0 | 0.7 | 0.5 | 0.2 | 0.0 | 0.2 | 0.5 | 0.7 | 1.0 | 1.2 | 1.5 | 1.7 | 2.0 |
| 60 | 1.2 | 0.9 | 0.6 | 0.2 | 0.0 | 0.2 | 0.6 | 0.9 | 1.2 | 1.5 | 1.8 | 2.1 | 2.5 |
| 70 | 1.5 | 1.1 | 0.7 | 0.4 | 0.0 | 0.4 | 0.7 | 1.1 | 1.5 | 1.8 | 2.1 | 2.5 | 2.8 |
| 80 | +1.6 | +1.2 | +0.8 | +0.4 | 0.0 | −0.4 | −0.8 | −1.2 | −1.6 | −2.1 | −2.5 | −2.8 | −3.3 |

## TABLE 28D.

### For finding the Latitude of a place by Altitudes of Polaris.

[D=the 4th correction.  (D has the same sign as A when the Dec. <88° 48′, the opposite sign when the Dec. >88° 48′.)]

[Vertical Argument, A = the 1st correction.   Horizontal Argument, the star's declination.]

| A. | Declination, 88° 47′ | | | | | | | | 88° 48′ | | | | | | Proportional parts. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20″ | 25″ | 30″ | 35″ | 40″ | 45″ | 50″ | 55″ | 0″ | 5″ | 10″ | 15″ | 20″ | 25″ | 1″ | 2″ | 3″ | 4″ |
| ′ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 1.1 | 1.0 | 0.8 | 0.7 | 0.6 | 0.4 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.4 | 0.6 | 0.7 | 0.0 | 0.0 | 0.1 | 0.1 |
| 4 | 2.2 | 1.9 | 1.7 | 1.4 | 1.1 | 0.8 | 0.6 | 0.3 | 0.0 | 0.3 | 0.6 | 0.8 | 1.1 | 1.4 | 0.1 | 0.1 | 0.2 | 0.2 |
| 6 | 3.3 | 2.9 | 2.5 | 2.1 | 1.7 | 1.2 | 0.8 | 0.4 | 0.0 | 0.4 | 0.8 | 1.2 | 1.7 | 2.1 | 0.1 | 0.2 | 0.2 | 0.3 |
| 8 | 4.4 | 3.9 | 3.3 | 2.8 | 2.2 | 1.7 | 1.1 | 0.6 | 0.0 | 0.6 | 1.1 | 1.7 | 2.2 | 2.8 | 0.1 | 0.2 | 0.3 | 0.4 |
| 10 | 5.6 | 4.9 | 4.2 | 3.4 | 2.8 | 2.1 | 1.4 | 0.7 | 0.0 | 0.7 | 1.4 | 2.1 | 2.8 | 3.4 | 0.1 | 0.3 | 0.4 | 0.6 |
| 12 | 6.7 | 5.8 | 5.0 | 4.2 | 3.3 | 2.5 | 1.7 | 0.8 | 0.0 | 0.8 | 1.7 | 2.5 | 3.3 | 4.1 | 0.2 | 0.3 | 0.5 | 0.6 |
| 14 | 7.8 | 6.8 | 5.8 | 4.9 | 3.9 | 2.9 | 1.9 | 1.0 | 0.0 | 1.0 | 1.9 | 2.9 | 3.9 | 4.9 | 0.2 | 0.4 | 0.6 | 0.8 |
| 16 | 8.9 | 7.8 | 6.7 | 5.5 | 4.4 | 3.3 | 2.2 | 1.1 | 0.0 | 1.1 | 2.2 | 3.3 | 4.4 | 5.5 | 0.2 | 0.4 | 0.7 | 0.9 |
| 18 | 10.0 | 8.8 | 7.5 | 6.2 | 5.0 | 3.8 | 2.5 | 1.2 | 0.0 | 1.2 | 2.5 | 3.8 | 5.0 | 6.2 | 0.2 | 0.5 | 0.7 | 1.0 |
| 20 | 11.1 | 9.7 | 8.3 | 6.9 | 5.5 | 4.2 | 2.8 | 1.4 | 0.0 | 1.4 | 2.8 | 4.2 | 5.5 | 6.9 | 0.3 | 0.6 | 0.8 | 1.1 |
| 22 | 12.2 | 10.7 | 9.2 | 7.7 | 6.1 | 4.6 | 3.0 | 1.6 | 0.0 | 1.6 | 3.0 | 4.6 | 6.1 | 7.7 | 0.3 | 0.6 | 0.9 | 1.3 |
| 24 | 13.3 | 11.7 | 10.0 | 8.3 | 6.7 | 5.0 | 3.3 | 1.7 | 0.0 | 1.7 | 3.3 | 5.0 | 6.7 | 8.3 | 0.3 | 0.7 | 1.0 | 1.4 |
| 26 | 14.4 | 12.7 | 10.8 | 9.0 | 7.2 | 5.4 | 3.6 | 1.8 | 0.0 | 1.8 | 3.6 | 5.4 | 7.2 | 9.0 | 0.4 | 0.7 | 1.1 | 1.4 |
| 28 | 15.6 | 13.6 | 11.7 | 9.7 | 7.8 | 5.8 | 3.9 | 1.9 | 0.0 | 1.9 | 3.9 | 5.8 | 7.8 | 9.7 | 0.4 | 0.8 | 1.1 | 1.5 |
| 30 | 16.7 | 14.6 | 12.5 | 10.4 | 8.3 | 6.2 | 4.2 | 2.1 | 0.0 | 2.1 | 4.2 | 6.2 | 8.3 | 10.4 | 0.4 | 0.8 | 1.3 | 1.7 |
| 32 | 17.8 | 15.6 | 13.3 | 11.1 | 8.9 | 6.7 | 4.4 | 2.2 | 0.0 | 2.2 | 4.4 | 6.7 | 8.9 | 11.1 | 0.4 | 0.9 | 1.3 | 1.8 |
| 34 | 18.9 | 16.6 | 14.2 | 11.8 | 9.4 | 7.1 | 4.7 | 2.3 | 0.0 | 2.3 | 4.7 | 7.1 | 9.4 | 11.8 | 0.5 | 0.9 | 1.4 | 1.9 |
| 36 | 20.0 | 17.5 | 15.0 | 12.5 | 10.0 | 7.5 | 5.0 | 2.5 | 0.0 | 2.5 | 5.0 | 7.5 | 10.0 | 12.5 | 0.5 | 1.0 | 1.5 | 2.0 |
| 38 | 21.1 | 18.4 | 15.8 | 13.2 | 10.6 | 7.9 | 5.3 | 2.7 | 0.0 | 2.7 | 5.3 | 7.9 | 10.6 | 13.2 | 0.5 | 1.1 | 1.6 | 2.1 |
| 40 | 22.2 | 19.4 | 16.7 | 13.9 | 11.1 | 8.3 | 5.6 | 2.8 | 0.0 | 2.8 | 5.6 | 8.3 | 11.1 | 13.9 | 0.6 | 1.1 | 1.7 | 2.2 |
| 42 | 23.3 | 20.4 | 17.6 | 14.6 | 11.7 | 8.8 | 5.8 | 2.9 | 0.0 | 2.9 | 5.8 | 8.8 | 11.7 | 14.6 | 0.6 | 1.2 | 1.7 | 2.3 |
| 44 | 24.4 | 21.4 | 18.3 | 15.3 | 12.2 | 9.2 | 6.1 | 3.0 | 0.0 | 3.0 | 6.1 | 9.2 | 12.2 | 15.3 | 0.6 | 1.2 | 1.8 | 2.4 |
| 46 | 25.6 | 22.3 | 19.2 | 16.0 | 12.8 | 9.6 | 6.4 | 3.2 | 0.0 | 3.2 | 6.4 | 9.6 | 12.8 | 16.0 | 0.6 | 1.3 | 1.9 | 2.6 |
| 48 | 26.7 | 23.3 | 20.0 | 16.7 | 13.3 | 10.0 | 6.7 | 3.3 | 0.0 | 3.3 | 6.7 | 10.0 | 13.3 | 16.7 | 0.7 | 1.3 | 2.0 | 2.6 |
| 50 | 27.8 | 24.3 | 20.8 | 17.3 | 13.9 | 10.4 | 6.9 | 3.4 | 0.0 | 3.4 | 6.9 | 10.4 | 13.9 | 17.3 | 0.7 | 1.4 | 2.1 | 2.8 |
| 52 | 28.9 | 25.3 | 21.7 | 18.0 | 14.4 | 10.8 | 7.2 | 3.6 | 0.0 | 3.6 | 7.2 | 10.8 | 14.4 | 18.0 | 0.7 | 1.4 | 2.2 | 2.9 |
| 54 | 30.0 | 26.2 | 22.5 | 18.8 | 15.0 | 11.2 | 7.5 | 3.8 | 0.0 | 3.8 | 7.5 | 11.2 | 15.0 | 18.8 | 0.7 | 1.5 | 2.2 | 3.0 |
| 56 | 31.1 | 27.2 | 23.3 | 19.4 | 15.6 | 11.7 | 7.8 | 3.9 | 0.0 | 3.9 | 7.8 | 11.7 | 15.6 | 19.4 | 0.8 | 1.6 | 2.3 | 3.1 |
| 58 | 32.2 | 28.2 | 24.2 | 20.1 | 16.1 | 12.1 | 8.0 | 4.0 | 0.0 | 4.0 | 8.0 | 12.1 | 16.1 | 20.1 | 0.8 | 1.6 | 2.4 | 3.2 |
| 60 | 33.3 | 29.2 | 25.0 | 20.8 | 16.7 | 12.5 | 8.3 | 4.2 | 0.0 | 4.2 | 8.3 | 12.5 | 16.7 | 20.8 | 0.8 | 1.7 | 2.5 | 3.3 |
| 62 | 34.4 | 30.1 | 25.8 | 21.5 | 17.2 | 12.9 | 8.6 | 4.3 | 0.0 | 4.3 | 8.6 | 12.9 | 17.2 | 21.5 | 0.9 | 1.7 | 2.6 | 3.4 |
| 64 | 35.6 | 31.1 | 26.7 | 22.2 | 17.8 | 13.3 | 8.9 | 4.4 | 0.0 | 4.4 | 8.9 | 13.3 | 17.8 | 22.2 | 0.9 | 1.8 | 2.7 | 3.6 |
| 66 | 36.7 | 32.1 | 27.5 | 22.9 | 18.3 | 13.8 | 9.2 | 4.6 | 0.0 | 4.6 | 9.2 | 13.8 | 18.3 | 22.9 | 0.9 | 1.8 | 2.8 | 3.7 |
| 68 | 37.8 | 33.0 | 28.3 | 23.6 | 18.9 | 14.2 | 9.4 | 4.7 | 0.0 | 4.7 | 9.4 | 14.2 | 18.9 | 23.6 | 0.9 | 1.9 | 2.8 | 3.8 |
| 70 | 38.9 | 34.0 | 29.2 | 24.3 | 19.4 | 14.6 | 9.7 | 4.9 | 0.0 | 4.9 | 9.7 | 14.6 | 19.4 | 24.3 | 1.0 | 1.9 | 2.9 | 3.9 |
| 72 | 40.0 | 35.0 | 30.0 | 25.0 | 20.0 | 15.0 | 10.0 | 5.0 | 0.0 | 5.0 | 10.0 | 15.0 | 20.0 | 25.0 | 1.0 | 2.0 | 3.0 | 4.0 |

#### Proportional parts.

| ′ ″ | 20″ | 25″ | 30″ | 35″ | 40″ | 45″ | 50″ | 55″ | 0″ | 5″ | 10″ | 15″ | 20″ | 25″ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 0 20 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| 0 40 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 |
| 1 00 | 0.6 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 |
| 1 20 | 0.7 | 0.7 | 0.5 | 0.5 | 0.4 | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 |
| 1 40 | 0.9 | 0.8 | 0.7 | 0.6 | 0.5 | 0.3 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 |
| 2 00 | 1.1 | 1.0 | 0.8 | 0.7 | 0.6 | 0.4 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.4 | 0.6 | 0.7 |

### For finding the Latitude of a place by Altitudes of Polaris.

[D=the 4th correction. (D has the same sign as A when the Dec. <88° 48', the opposite sign when the Dec. >88° 48'.)]

[Vertical Argument A=the 1st correction. Horizontal Argument, the star's declination.]

| A. | Declination, 88° 48' | | | | | | 88° 49' | | | | | Proportional parts. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30″ | 35″ | 40″ | 45″ | 50″ | 55″ | 0″ | 5″ | 10″ | 15″ | 20″ | 1″ | 2″ | 3″ | 4″ |
| ′ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.8 | 1.0 | 1.1 | 1.2 | 1.4 | 1.6 | 1.7 | 1.8 | 1.9 | 2.1 | 2.2 | 0.0 | 0.1 | 0.1 | 0.1 |
| 4 | 1.7 | 1.9 | 2.2 | 2.5 | 2.8 | 3.1 | 3.3 | 3.6 | 3.9 | 4.2 | 4.4 | 0.1 | 0.1 | 0.1 | 0.2 |
| 6 | 2.5 | 2.9 | 3.3 | 3.8 | 4.2 | 4.6 | 5.0 | 5.3 | 5.8 | 6.2 | 6.7 | 0.1 | 0.2 | 0.2 | 0.3 |
| 8 | 3.3 | 3.9 | 4.4 | 5.0 | 5.6 | 6.1 | 6.7 | 7.2 | 7.8 | 8.3 | 8.9 | 0.1 | 0.2 | 0.3 | 0.4 |
| 10 | 4.2 | 4.9 | 5.6 | 6.2 | 6.9 | 7.6 | 8.3 | 9.0 | 9.7 | 10.4 | 11.1 | 0.1 | 0.3 | 0.4 | 0.6 |
| 12 | 5.0 | 5.8 | 6.7 | 7.5 | 8.3 | 9.2 | 10.0 | 10.8 | 11.7 | 12.5 | 13.3 | 0.2 | 0.3 | 0.5 | 0.7 |
| 14 | 5.8 | 6.8 | 7.8 | 8.8 | 9.8 | 10.8 | 11.8 | 12.7 | 13.7 | 14.6 | 15.6 | 0.2 | 0.4 | 0.6 | 0.8 |
| 16 | 6.7 | 7.8 | 8.9 | 10.0 | 11.1 | 12.2 | 13.3 | 14.4 | 15.6 | 16.7 | 17.8 | 0.2 | 0.4 | 0.7 | 0.9 |
| 18 | 7.5 | 8.8 | 10.0 | 11.2 | 12.5 | 13.8 | 15.0 | 16.2 | 17.5 | 18.8 | 20.0 | 0.2 | 0.5 | 0.7 | 1.0 |
| 20 | 8.3 | 9.7 | 11.1 | 12.5 | 13.9 | 15.3 | 16.7 | 18.1 | 19.4 | 20.9 | 22.2 | 0.3 | 0.6 | 0.8 | 1.1 |
| 22 | 9.2 | 10.7 | 12.2 | 13.8 | 15.3 | 16.8 | 18.3 | 19.8 | 21.4 | 22.9 | 24.4 | 0.3 | 0.6 | 1.0 | 1.3 |
| 24 | 10.0 | 11.7 | 13.3 | 15.0 | 16.7 | 18.4 | 20.0 | 21.7 | 23.3 | 25.0 | 26.7 | 0.3 | 0.7 | 1.0 | 1.4 |
| 26 | 10.8 | 12.7 | 14.4 | 16.2 | 18.0 | 19.9 | 21.7 | 23.5 | 25.3 | 27.1 | 28.9 | 0.4 | 0.7 | 1.1 | 1.4 |
| 28 | 11.7 | 13.6 | 15.6 | 17.5 | 19.4 | 21.4 | 23.3 | 25.3 | 27.2 | 29.2 | 31.1 | 0.4 | 0.8 | 1.2 | 1.6 |
| 30 | 12.5 | 14.6 | 16.7 | 18.8 | 20.8 | 22.9 | 25.0 | 27.1 | 29.2 | 31.2 | 33.3 | 0.4 | 0.8 | 1.2 | 1.6 |
| 32 | 13.3 | 15.6 | 17.8 | 20.0 | 22.2 | 24.4 | 26.7 | 28.9 | 31.1 | 33.3 | 35.5 | 0.4 | 0.9 | 1.3 | 1.8 |
| 34 | 14.2 | 16.6 | 18.9 | 21.2 | 23.6 | 26.0 | 28.4 | 30.7 | 33.1 | 35.4 | 37.8 | 0.5 | 0.9 | 1.4 | 1.9 |
| 36 | 15.0 | 17.5 | 20.0 | 22.5 | 25.0 | 27.5 | 30.0 | 32.5 | 35.0 | 37.5 | 40.0 | 0.5 | 1.0 | 1.5 | 2.0 |
| 38 | 15.8 | 18.4 | 21.1 | 23.8 | 26.4 | 29.0 | 31.6 | 34.2 | 37.0 | 39.6 | 42.2 | 0.5 | 1.1 | 1.6 | 2.2 |
| 40 | 16.7 | 19.4 | 22.2 | 25.0 | 27.8 | 30.6 | 33.3 | 36.1 | 38.9 | 41.7 | 44.4 | 0.6 | 1.1 | 1.7 | 2.2 |
| 42 | 17.6 | 20.4 | 23.3 | 26.2 | 29.2 | 32.1 | 35.0 | 37.9 | 40.8 | 43.8 | 46.7 | 0.6 | 1.2 | 1.8 | 2.4 |
| 44 | 18.3 | 21.4 | 24.4 | 27.5 | 30.6 | 33.7 | 36.8 | 39.8 | 42.8 | 45.9 | 48.9 | 0.6 | 1.2 | 1.8 | 2.4 |
| 46 | 19.2 | 22.3 | 25.6 | 28.8 | 32.0 | 35.1 | 38.3 | 41.5 | 44.8 | 47.9 | 51.1 | 0.6 | 1.3 | 1.9 | 2.6 |
| 48 | 20.0 | 23.3 | 26.7 | 30.0 | 33.3 | 36.7 | 40.0 | 43.3 | 46.7 | 50.0 | 53.3 | 0.7 | 1.3 | 2.0 | 2.7 |
| 50 | 20.8 | 24.3 | 27.8 | 31.2 | 34.7 | 38.2 | 41.7 | 45.1 | 48.6 | 52.1 | 55.5 | 0.7 | 1.4 | 2.1 | 2.8 |
| 52 | 21.7 | 25.3 | 28.9 | 32.5 | 36.1 | 39.7 | 43.3 | 46.9 | 50.5 | 54.2 | 57.8 | 0.7 | 1.4 | 2.2 | 2.9 |
| 54 | 22.5 | 26.2 | 30.0 | 33.8 | 37.5 | 41.2 | 45.0 | 48.7 | 52.5 | 56.2 | 60.0 | 0.7 | 1.5 | 2.2 | 3.0 |
| 56 | 23.3 | 27.2 | 31.1 | 35.0 | 38.9 | 42.8 | 46.7 | 50.5 | 54.4 | 58.3 | 62.2 | 0.8 | 1.6 | 2.3 | 3.1 |
| 58 | 24.2 | 28.2 | 32.2 | 36.2 | 40.3 | 44.3 | 48.3 | 52.3 | 56.4 | 60.4 | 64.4 | 0.8 | 1.6 | 2.4 | 3.2 |
| 60 | 25.0 | 29.2 | 33.3 | 37.5 | 41.7 | 45.9 | 50.0 | 54.2 | 58.3 | 62.5 | 66.7 | 0.8 | 1.7 | 2.5 | 3.3 |
| 62 | 25.8 | 30.1 | 34.4 | 38.8 | 43.0 | 47.3 | 51.7 | 56.0 | 60.3 | 64.6 | 68.9 | 0.9 | 1.7 | 2.6 | 3.4 |
| 64 | 26.7 | 31.1 | 35.6 | 40.0 | 44.4 | 48.9 | 53.3 | 57.8 | 62.2 | 66.7 | 71.1 | 0.9 | 1.8 | 2.7 | 3.6 |
| 66 | 27.5 | 32.1 | 36.7 | 41.2 | 45.8 | 50.4 | 55.0 | 59.6 | 64.2 | 68.8 | 73.3 | 0.9 | 1.8 | 2.7 | 3.6 |
| 68 | 28.3 | 33.0 | 37.8 | 42.5 | 47.2 | 52.0 | 56.7 | 61.3 | 66.1 | 70.9 | 75.5 | 0.9 | 1.9 | 2.8 | 3.8 |
| 70 | 29.2 | 34.0 | 38.9 | 43.8 | 48.6 | 53.5 | 58.3 | 63.1 | 68.0 | 72.9 | 77.7 | 1.0 | 1.9 | 2.9 | 3.9 |
| 72 | 30.0 | 35.0 | 40.0 | 45.0 | 50.0 | 55.0 | 60.0 | 65.0 | 70.0 | 75.0 | 80.0 | 1.0 | 2.0 | 3.0 | 4.0 |

#### Proportional parts.

| ′ ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ | ″ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 20 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 |
| 0 40 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 |
| 1 00 | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | 1.1 |
| 1 20 | 0.5 | 0.7 | 0.7 | 0.8 | 0.9 | 1.1 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 |
| 1 40 | 0.6 | 0.8 | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 |
| 2 00 | 0.8 | 1.0 | 1.1 | 1.2 | 1.4 | 1.6 | 1.7 | 1.8 | 1.9 | 2.1 | 2.2 |

TABLE 29.

Conversion Tables for Nautical and Statute Miles.

| | | Nautical miles into statute miles. | | | | | | Statute miles into nautical miles. | | | |
| | | 1 nautical mile or knot = 6,080 feet. | | | | | | 1 statute mile = 5,280 feet. | | | |
| | | 1 statute mile = 5,280 feet. | | | | | | 1 nautical mile or knot = 6,080 feet. | | | |
| Nautical miles. | Statute miles. | Nautical miles. | Statute miles. | Nautical miles. | Statute miles. | Statute miles. | Nautical miles. | Statute miles. | Nautical miles. | Statute miles. | Nautical miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 1.151 | 8.75 | 10.075 | 16.50 | 18.999 | 1.00 | 0.868 | 9.00 | 7.815 | 17.00 | 14.763 |
| 1.25 | 1.439 | 9.00 | 10.363 | 16.75 | 19.287 | 1.25 | 1.085 | 9.25 | 8.032 | 17.25 | 14.980 |
| 1.50 | 1.727 | 9.25 | 10.651 | 17.00 | 19.575 | 1.50 | 1.302 | 9.50 | 8.249 | 17.50 | 15.197 |
| 1.75 | 2.015 | 9.50 | 10.939 | 17.25 | 19.863 | 1.75 | 1.519 | 9.75 | 8.467 | 17.75 | 15.414 |
| 2.00 | 2.303 | 9.75 | 11.227 | 17.50 | 20.151 | 2.00 | 1.736 | 10.00 | 8.684 | 18.00 | 15.632 |
| 2.25 | 2.590 | 10.00 | 11.515 | 17.75 | 20.439 | 2.25 | 1.953 | 10.25 | 8.901 | 18.25 | 15.849 |
| 2.50 | 2.878 | 10.25 | 11.803 | 18.00 | 20.727 | 2.50 | 2.170 | 10.50 | 9.118 | 18.50 | 16.066 |
| 2.75 | 3.166 | 10.50 | 12.090 | 18.25 | 21.015 | 2.75 | 2.387 | 10.75 | 9.335 | 18.75 | 16.283 |
| 3.00 | 3.454 | 10.75 | 12.378 | 18.50 | 21.303 | 3.00 | 2.604 | 11.00 | 9.552 | 19.00 | 16.500 |
| 3.25 | 3.742 | 11.00 | 12.666 | 18.75 | 21.590 | 3.25 | 2.821 | 11.25 | 9.769 | 19.25 | 16.717 |
| 3.50 | 4.030 | 11.25 | 12.954 | 19.00 | 21.878 | 3.50 | 3.038 | 11.50 | 9.986 | 19.50 | 16.934 |
| 3.75 | 4.318 | 11.50 | 13.242 | 19.25 | 22.166 | 3.75 | 3.256 | 11.75 | 10.203 | 19.75 | 17.151 |
| 4.00 | 4.606 | 11.75 | 13.530 | 19.50 | 22.454 | 4.00 | 3.473 | 12.00 | 10.420 | 20.00 | 17.369 |
| 4.25 | 4.893 | 12.00 | 13.818 | 19.75 | 22.742 | 4.25 | 3.690 | 12.25 | 10.638 | 20.25 | 17.586 |
| 4.50 | 5.181 | 12.25 | 14.106 | 20.00 | 23.030 | 4.50 | 3.907 | 12.50 | 10.855 | 20.50 | 17.803 |
| 4.75 | 5.469 | 12.50 | 14.393 | 20.25 | 23.318 | 4.75 | 4.124 | 12.75 | 11.072 | 20.75 | 18.020 |
| 5.00 | 5.757 | 12.75 | 14.681 | 20.50 | 23.606 | 5.00 | 4.341 | 13.00 | 11.289 | 21.00 | 18.237 |
| 5.25 | 6.045 | 13.00 | 14.969 | 20.75 | 23.893 | 5.25 | 4.559 | 13.25 | 11.507 | 21.25 | 18.454 |
| 5.50 | 6.333 | 13.25 | 15.257 | 21.00 | 24.181 | 5.50 | 4.776 | 13.50 | 11.724 | 21.50 | 18.671 |
| 5.75 | 6.621 | 13.50 | 15.545 | 21.25 | 24.469 | 5.75 | 4.994 | 13.75 | 11.941 | 21.75 | 18.888 |
| 6.00 | 6.909 | 13.75 | 15.833 | 21.50 | 24.757 | 6.00 | 5.211 | 14.00 | 12.158 | 22.00 | 19.105 |
| 6.25 | 7.196 | 14.00 | 16.121 | 21.75 | 25.045 | 6.25 | 5.428 | 14.25 | 12.376 | 22.25 | 19.322 |
| 6.50 | 7.484 | 14.25 | 16.409 | 22.00 | 25.333 | 6.50 | 5.645 | 14.50 | 12.593 | 22.50 | 19.539 |
| 6.75 | 7.772 | 14.50 | 16.696 | 22.25 | 25.621 | 6.75 | 5.862 | 14.75 | 12.810 | 22.75 | 19.756 |
| 7.00 | 8.060 | 14.75 | 16.984 | 22.50 | 25.909 | 7.00 | 6.079 | 15.00 | 13.027 | 23.00 | 19.973 |
| 7.25 | 8.348 | 15.00 | 17.272 | 22.75 | 26.196 | 7.25 | 6.296 | 15.25 | 13.244 | 23.25 | 20.191 |
| 7.50 | 8.636 | 15.25 | 17.560 | 23.00 | 26.484 | 7.50 | 6.513 | 15.50 | 13.461 | 23.50 | 20.408 |
| 7.75 | 8.924 | 15.50 | 17.848 | 23.50 | 27.060 | 7.75 | 6.730 | 15.75 | 13.678 | 23.75 | 20.625 |
| 8.00 | 9.212 | 15.75 | 18.136 | 24.00 | 27.636 | 8.00 | 6.947 | 16.00 | 13.895 | 24.00 | 20.842 |
| 8.25 | 9.500 | 16.00 | 18.424 | 24.50 | 28.212 | 8.25 | 7.164 | 16.25 | 14.112 | 24.25 | 21.060 |
| 8.50 | 9.787 | 16.25 | 18.712 | 25.00 | 28.787 | 8.50 | 7.381 | 16.50 | 14.329 | 24.50 | 21.277 |
| | | | | | | 8.75 | 7.598 | 16.75 | 14.546 | 25.00 | 21.711 |

# TABLE 30.

## Conversion Tables for Metric and English Linear Measure.

*Metric to English.*

| Meters. | Feet. | | | Yards. | | | Statute miles. | | | Nautical miles. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.280 | 833 | 3 | 1.093 | 611 | 1 | 0.000 | 621 | 369 | 0.000 | 539 | 593 |
| 2 | 6.561 | 666 | 7 | 2.187 | 222 | 2 | .001 | 242 | 738 | .001 | 079 | 185 |
| 3 | 9.842 | 500 | 0 | 3.280 | 833 | 3 | .001 | 864 | 106 | .001 | 618 | 778 |
| 4 | 13.123 | 333 | 3 | 4.374 | 444 | 4 | .002 | 485 | 475 | .002 | 158 | 370 |
| 5 | 16.404 | 166 | 7 | 5.468 | 055 | 6 | .003 | 106 | 844 | .002 | 697 | 963 |
| 6 | 19.685 | 000 | 0 | 6.561 | 666 | 7 | .003 | 728 | 213 | .003 | 237 | 556 |
| 7 | 22.965 | 833 | 3 | 7.655 | 277 | 8 | .004 | 349 | 582 | .003 | 777 | 148 |
| 8 | 26.246 | 666 | 7 | 8.748 | 888 | 9 | .004 | 970 | 950 | .004 | 316 | 741 |
| 9 | 29.527 | 500 | 0 | 9.842 | 500 | 0 | .005 | 592 | 319 | .004 | 856 | 333 |

*English to metric.*

| No. | Feet to meters. | | | Yards to meters. | | | Statute miles to meters. | Nautical miles to meters. |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.304 | 800 | 6 | 0.914 | 401 | 8 | 1,609.35 | 1,853.25 |
| 2 | 0.609 | 601 | 2 | 1.828 | 803 | 7 | 3,218.70 | 3,706.50 |
| 3 | 0.914 | 401 | 8 | 2.743 | 205 | 5 | 4,828.05 | 5,559.75 |
| 4 | 1.219 | 202 | 4 | 3.657 | 607 | 3 | 6,437.40 | 7,413.00 |
| 5 | 1.524 | 003 | 0 | 4.572 | 009 | 1 | 8,046.75 | 9,266.25 |
| 6 | 1.828 | 803 | 7 | 5.486 | 411 | 0 | 9,656.10 | 11,119.50 |
| 7 | 2.133 | 604 | 3 | 6.400 | 812 | 8 | 11,265.45 | 12,972.75 |
| 8 | 2.438 | 404 | 9 | 7.315 | 214 | 6 | 12,874.80 | 14,826.00 |
| 9 | 2.743 | 205 | 5 | 8.229 | 616 | 5 | 14,484.15 | 16,679.25 |

# TABLE 31.

## Conversion Tables for Thermometer Scales.

[F°=Fahrenheit temperature; C°=Centigrade temperature; R°=Réaumur temperature.]

*Equivalent temperatures—Fahr., Cent., Réau*

$$R° = \tfrac{4}{5} C° = \tfrac{4}{9} (F° - 32°).$$
$$C° = \tfrac{5}{4} R° = \tfrac{5}{9} (F° - 32°).$$

| F°. | C°. | R°. | F°. | C°. | R°. |
|---|---|---|---|---|---|
| 1 | −17.2 | −13.8 | 51 | +10.6 | + 8.4 |
| 2 | 16.7 | 13.3 | 52 | 11.1 | 8.9 |
| 3 | 16.1 | 12.9 | 53 | 11.7 | 9.3 |
| 4 | 15.6 | 12.4 | 54 | 12.2 | 9.8 |
| 5 | 15.0 | 12.0 | 55 | 12.8 | 10.2 |
| 6 | 14.4 | 11.6 | 56 | 13.3 | 10.7 |
| 7 | 13.9 | 11.1 | 57 | 13.9 | 11.1 |
| 8 | 13.3 | 10.7 | 58 | 14.4 | 11.6 |
| 9 | 12.8 | 10.2 | 59 | 15.0 | 12.0 |
| 10 | 12.2 | 9.8 | 60 | 15.6 | 12.4 |
| 11 | 11.7 | 9.3 | 61 | 16.1 | 12.9 |
| 12 | 11.1 | 8.9 | 62 | 16.7 | 13.3 |
| 13 | 10.6 | 8.4 | 63 | 17.2 | 13.8 |
| 14 | 10.0 | 8.0 | 64 | 17.8 | 14.2 |
| 15 | 9.4 | 7.6 | 65 | 18.3 | 14.7 |
| 16 | 8.9 | 7.1 | 66 | 18.9 | 15.1 |
| 17 | 8.3 | 6.7 | 67 | 19.4 | 15.6 |
| 18 | 7.8 | 6.2 | 68 | 20.0 | 16.0 |
| 19 | 7.2 | 5.8 | 69 | 20.6 | 16.4 |
| 20 | 6.7 | 5.3 | 70 | 21.1 | 16.9 |
| 21 | 6.1 | 4.9 | 71 | 21.7 | 17.3 |
| 22 | 5.6 | 4.4 | 72 | 22.2 | 17.8 |
| 23 | 5.0 | 4.0 | 73 | 22.8 | 18.2 |
| 24 | 4.4 | 3.6 | 74 | 23.3 | 18.7 |
| 25 | 3.9 | 3.1 | 75 | 23.9 | 19.1 |
| 26 | 3.3 | 2.7 | 76 | 24.4 | 19.6 |
| 27 | 2.8 | 2.2 | 77 | 25.0 | 20.0 |
| 28 | 2.2 | 1.8 | 78 | 25.6 | 20.4 |
| 29 | 1.7 | 1.3 | 79 | 26.1 | 20.9 |
| 30 | 1.1 | 0.9 | 80 | 26.7 | 21.3 |
| 31 | − 0.6 | − 0.4 | 81 | 27.2 | 21.8 |
| 32 | 0.0 | 0.0 | 82 | 27.8 | 22.2 |
| 33 | + 0.6 | + 0.4 | 83 | 28.3 | 22.7 |
| 34 | 1.1 | 0.9 | 84 | 28.9 | 23.1 |
| 35 | 1.7 | 1.3 | 85 | 29.4 | 23.6 |
| 36 | 2.2 | 1.8 | 86 | 30.0 | 24.0 |
| 37 | 2.8 | 2.2 | 87 | 30.6 | 24.4 |
| 38 | 3.3 | 2.7 | 88 | 31.1 | 24.9 |
| 39 | 3.9 | 3.1 | 89 | 31.7 | 25.3 |
| 40 | 4.4 | 3.6 | 90 | 32.2 | 25.8 |
| 41 | 5.0 | 4.0 | 91 | 32.8 | 26.2 |
| 42 | 5.6 | 4.4 | 92 | 33.3 | 26.7 |
| 43 | 6.1 | 4.9 | 93 | 33.9 | 27.1 |
| 44 | 6.7 | 5.3 | 94 | 34.4 | 27.6 |
| 45 | 7.2 | 5.8 | 95 | 35.0 | 28.0 |
| 46 | 7.8 | 6.2 | 96 | 35.6 | 28.4 |
| 47 | 8.3 | 6.7 | 97 | 36.1 | 28.9 |
| 48 | 8.9 | 7.1 | 98 | 36.7 | 29.3 |
| 49 | 9.4 | 7.6 | 99 | 37.2 | 29.8 |
| 50 | +10.0 | + 8.0 | 100 | +37.8 | +30.2 |

*Equivalent temperatures—Centigrade and Fahrenheit.*

$$F° = \tfrac{9}{5} C° + 32°.$$

| C°. | F°. | C°. | F°. | C°. | F°. | C°. | F°. | C°. | F°. |
|---|---|---|---|---|---|---|---|---|---|
| −10 | 14.0 | 0 | 32.0 | 10 | 50.0 | 20 | 68.0 | 30 | 86.0 |
| − 9 | 15.8 | 1 | 33.8 | 11 | 51.8 | 21 | 69.8 | 31 | 87.8 |
| − 8 | 17.6 | 2 | 35.6 | 12 | 53.6 | 22 | 71.6 | 32 | 89.6 |
| − 7 | 19.4 | 3 | 37.4 | 13 | 55.4 | 23 | 73.4 | 33 | 91.4 |
| − 6 | 21.2 | 4 | 39.2 | 14 | 57.2 | 24 | 75.2 | 34 | 93.2 |
| − 5 | 23.0 | 5 | 41.0 | 15 | 59.0 | 25 | 77.0 | 35 | 95.0 |
| − 4 | 24.8 | 6 | 42.8 | 16 | 60.8 | 26 | 78.8 | 36 | 96.8 |
| − 3 | 26.6 | 7 | 44.6 | 17 | 62.6 | 27 | 80.6 | 37 | 98.6 |
| − 2 | 28.4 | 8 | 46.4 | 18 | 64.4 | 28 | 82.4 | 38 | 100.4 |
| − 1 | 30.2 | 9 | 48.2 | 19 | 66.2 | 29 | 84.2 | 39 | 102.2 |

*Equivalent temperatures—Réaumur and Fahrenheit.*

$$F° = \tfrac{9}{4} R° + 32°.$$

| R°. | F°. | R°. | F°. | R°. | F°. | R°. | F°. |
|---|---|---|---|---|---|---|---|
| −10 | 9.5 | 0 | 32.0 | 10 | 54.5 | 20 | 77.0 |
| − 9 | 11.8 | 1 | 34.2 | 11 | 56.8 | 21 | 79.2 |
| − 8 | 14.0 | 2 | 36.5 | 12 | 59.0 | 22 | 81.5 |
| − 7 | 16.2 | 3 | 38.8 | 13 | 61.2 | 23 | 83.8 |
| − 6 | 18.5 | 4 | 41.0 | 14 | 63.5 | 24 | 86.0 |
| − 5 | 20.8 | 5 | 43.2 | 15 | 65.8 | 25 | 88.2 |
| − 4 | 23.0 | 6 | 45.5 | 16 | 68.0 | 26 | 90.5 |
| − 3 | 25.2 | 7 | 47.8 | 17 | 70.2 | 27 | 92.8 |
| − 2 | 27.5 | 8 | 50.0 | 18 | 72.5 | 28 | 95.0 |
| − 1 | 29.8 | 9 | 52.2 | 19 | 74.8 | 29 | 97.2 |

TABLE 32. [Page 565

To obtain the True Force and Direction of the Wind from its Apparent Force and Direction on a Moving Vessel.

Apparent direction of the wind (points of the bow).

Columns (Apparent direction of the wind): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 — each giving "True force, Beaufort scale." and "True direction, points off the bow."

Speed of vessel, knots.

Apparent force of the wind (Beaufort scale): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

# TABLE 33.

### Distance by Vertical Angle.

Heights in feet.

| Dist., knots. | 150 | 140 | 130 | 120 | 110 | 100 | 95 | 90 | 85 | 80 | 75 | 70 | 65 | 60 | 55 | 50 | 45 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 13 52 | 12 58 | 12 04 | 11 10 | 10 15 | 9 20 | 8 53 | 8 25 | 7 58 | 7 30 | 7 02 | 6 34 | 6 06 | 5 38 | 5 10 | 4 42 | 4 14 | 3 46 |
| .2 | 7 02 | 6 34 | 6 06 | 5 38 | 5 10 | 4 42 | 4 28 | 4 14 | 4 00 | 3 46 | 3 32 | 3 18 | 3 04 | 2 49 | 2 35 | 2 21 | 2 07 | 1 53 |
| .3 | 4 42 | 4 23 | 4 05 | 3 46 | 3 27 | 3 08 | 2 59 | 2 49 | 2 40 | 2 31 | 2 21 | 2 12 | 2 02 | 1 53 | 1 44 | 1 34 | 1 25 | 1 15 |
| .4 | 3 32 | 3 18 | 3 04 | 2 49 | 2 35 | 2 21 | 2 14 | 2 07 | 2 00 | 1 53 | 1 46 | 1 39 | 1 32 | 1 25 | 1 18 | 1 11 | 1 04 | 0 57 |
| 0.5 | 2 49 | 2 38 | 2 27 | 2 16 | 2 04 | 1 53 | 1 47 | 1 42 | 1 36 | 1 30 | 1 25 | 1 19 | 1 14 | 1 08 | 1 02 | 0 57 | 0 51 | 0 45 |
| .6 | 2 21 | 2 12 | 2 02 | 1 53 | 1 44 | 1 34 | 1 30 | 1 25 | 1 20 | 1 15 | 1 11 | 1 06 | 1 01 | 0 57 | 0 52 | 0 47 | 0 42 | 0 38 |
| .7 | 2 01 | 1 53 | 1 45 | 1 37 | 1 29 | 1 21 | 1 17 | 1 13 | 1 09 | 1 05 | 1 01 | 0 57 | 0 53 | 0 48 | 0 44 | 0 40 | 0 36 | 0 32 |
| .8 | 1 46 | 1 39 | 1 32 | 1 25 | 1 18 | 1 11 | 1 07 | 1 04 | 1 00 | 0 57 | 0 53 | 0 49 | 0 46 | 0 42 | 0 39 | 0 35 | 0 32 | 0 28 |
| .9 | 1 34 | 1 28 | 1 22 | 1 15 | 1 09 | 1 03 | 1 00 | 0 57 | 0 53 | 0 50 | 0 47 | 0 44 | 0 41 | 0 38 | 0 35 | 0 31 | 0 28 | 0 25 |
| 1.0 | 1 25 | 1 19 | 1 14 | 1 08 | 1 02 | 0 57 | 0 54 | 0 51 | 0 48 | 0 45 | 0 42 | 0 40 | 0 37 | 0 34 | 0 31 | 0 28 | 0 25 | 0 23 |
| .1 | 1 17 | 1 12 | 1 07 | 1 02 | 0 57 | 0 51 | 0 49 | 0 46 | 0 44 | 0 41 | 0 39 | 0 36 | 0 33 | 0 31 | 0 28 | 0 26 | 0 23 | 0 21 |
| .2 | 1 11 | 1 06 | 1 01 | 0 57 | 0 52 | 0 47 | 0 45 | 0 42 | 0 40 | 0 38 | 0 35 | 0 33 | 0 31 | 0 28 | 0 26 | 0 24 | 0 21 | 0 19 |
| .3 | 1 06 | 1 01 | 0 57 | 0 52 | 0 48 | 0 44 | 0 41 | 0 39 | 0 37 | 0 35 | 0 33 | 0 30 | 0 28 | 0 26 | 0 24 | 0 22 | 0 20 | 0 17 |
| .4 | 1 01 | 0 57 | 0 53 | 0 48 | 0 44 | 0 40 | 0 38 | 0 36 | 0 34 | 0 32 | 0 30 | 0 28 | 0 26 | 0 24 | 0 22 | 0 20 | 0 18 | 0 16 |
| 1.5 | 0 57 | 0 53 | 0 49 | 0 45 | 0 41 | 0 38 | 0 36 | 0 34 | 0 32 | 0 30 | 0 28 | 0 26 | 0 25 | 0 23 | 0 21 | 0 19 | 0 17 | 0 15 |
| .6 | 0 53 | 0 49 | 0 46 | 0 42 | 0 39 | 0 35 | 0 34 | 0 32 | 0 30 | 0 28 | 0 27 | 0 25 | 0 23 | 0 21 | 0 19 | 0 18 | 0 16 | 0 14 |
| .7 | 0 50 | 0 47 | 0 43 | 0 40 | 0 37 | 0 33 | 0 32 | 0 30 | 0 28 | 0 27 | 0 25 | 0 23 | 0 22 | 0 20 | 0 18 | 0 17 | 0 15 | 0 13 |
| .8 | 0 47 | 0 44 | 0 41 | 0 38 | 0 35 | 0 31 | 0 30 | 0 28 | 0 27 | 0 25 | 0 24 | 0 22 | 0 20 | 0 19 | 0 17 | 0 16 | 0 14 | 0 13 |
| .9 | 0 45 | 0 42 | 0 39 | 0 36 | 0 33 | 0 30 | 0 28 | 0 27 | 0 25 | 0 24 | 0 22 | 0 21 | 0 19 | 0 18 | 0 16 | 0 15 | 0 13 | 0 12 |
| 2.0 | 0 42 | 0 40 | 0 37 | 0 34 | 0 31 | 0 28 | 0 27 | 0 25 | 0 24 | 0 23 | 0 21 | 0 20 | 0 18 | 0 17 | 0 15 | 0 14 | 0 13 | 0 11 |
| .1 | 0 40 | 0 38 | 0 35 | 0 32 | 0 30 | 0 27 | 0 26 | 0 24 | 0 23 | 0 22 | 0 20 | 0 19 | 0 18 | 0 16 | 0 15 | 0 14 | 0 13 | 0 11 |
| .2 | 0 39 | 0 36 | 0 33 | 0 31 | 0 28 | 0 26 | 0 24 | 0 23 | 0 22 | 0 21 | 0 19 | 0 18 | 0 17 | 0 15 | 0 14 | 0 13 | 0 12 | 0 10 |
| .3 | 0 37 | 0 34 | 0 32 | 0 30 | 0 27 | 0 25 | 0 23 | 0 22 | 0 21 | 0 20 | 0 18 | 0 17 | 0 16 | 0 14 | 0 14 | 0 12 | 0 12 | 0 10 |
| .4 | 0 35 | 0 33 | 0 31 | 0 28 | 0 26 | 0 24 | 0 22 | 0 21 | 0 20 | 0 19 | 0 18 | 0 17 | 0 15 | 0 14 | 0 13 | 0 12 | 0 11 | 0 10 |
| 2.5 | 0 34 | 0 32 | 0 29 | 0 27 | 0 25 | 0 23 | 0 21 | 0 20 | 0 19 | 0 18 | 0 17 | 0 16 | 0 15 | 0 13 | 0 12 | 0 11 | 0 11 | 0 9 |
| .6 | 0 33 | 0 30 | 0 28 | 0 26 | 0 24 | 0 22 | 0 21 | 0 20 | 0 18 | 0 17 | 0 16 | 0 15 | 0 14 | 0 13 | 0 12 | 0 11 | 0 10 | 0 9 |
| .7 | 0 31 | 0 29 | 0 27 | 0 25 | 0 23 | 0 21 | 0 20 | 0 19 | 0 17 | 0 17 | 0 15 | 0 15 | 0 14 | 0 12 | 0 11 | 0 10 | 0 10 | 0 9 |
| .8 | 0 30 | 0 28 | 0 26 | 0 24 | 0 22 | 0 20 | 0 19 | 0 18 | 0 17 | 0 16 | 0 15 | 0 14 | 0 13 | 0 12 | 0 11 | 0 10 | 0 9 | 0 8 |
| .9 | 0 29 | 0 27 | 0 25 | 0 23 | 0 21 | 0 20 | 0 19 | 0 17 | 0 16 | 0 15 | 0 14 | 0 14 | 0 13 | 0 11 | 0 10 | 0 10 | 0 9 | 0 8 |
| 3.0 | 0 28 | 0 26 | 0 25 | 0 23 | 0 21 | 0 19 | 0 18 | 0 17 | 0 15 | 0 15 | 0 13 | 0 13 | 0 12 | 0 10 | 0 10 | 0 9 | 0 9 | 0 8 |
| .2 | 0 27 | 0 25 | 0 23 | 0 21 | 0 19 | 0 18 | 0 17 | 0 16 | 0 14 | 0 14 | 0 12 | 0 12 | | | | | | |
| .4 | 0 25 | 0 23 | 0 22 | 0 20 | 0 18 | 0 17 | 0 16 | 0 15 | 0 13 | 0 13 | 0 12 | 0 11 | | | | | | |
| .6 | 0 24 | 0 22 | 0 20 | 0 19 | 0 17 | 0 16 | 0 15 | 0 14 | 0 13 | 0 13 | 0 11 | 0 10 | | | | | | |
| .8 | 0 22 | 0 21 | 0 19 | 0 18 | 0 16 | 0 15 | 0 14 | 0 13 | 0 12 | 0 12 | 0 11 | 0 10 | | | | | | |
| 4.0 | 0 21 | 0 20 | 0 18 | 0 17 | 0 16 | 0 14 | 0 13 | 0 13 | 0 11 | 0 11 | 0 11 | 0 10 | | | | | | |
| .2 | 0 20 | 0 19 | 0 17 | 0 16 | 0 15 | 0 13 | 0 13 | 0 12 | 0 11 | | | | | | | | | |
| .4 | 0 19 | 0 18 | 0 16 | 0 15 | 0 14 | 0 13 | 0 12 | 0 11 | 0 10 | | | | | | | | | |
| .6 | 0 18 | 0 17 | 0 16 | 0 15 | 0 13 | 0 12 | 0 12 | 0 11 | 0 10 | | | | | | | | | |
| .8 | 0 18 | 0 16 | 0 15 | 0 14 | 0 13 | 0 12 | 0 11 | 0 10 | 0 10 | | | | | | | | | |
| 5.0 | 0 17 | 0 16 | 0 15 | 0 14 | 0 12 | 0 11 | 0 11 | 0 10 | 0 10 | | | | | | | | | |

# TABLE 33.

### Distance by Vertical Angle.

Heights in feet. — Values given as degrees ° and minutes ′.

| Dist., knots | 160 | 170 | 180 | 190 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1,000 | 1,200 | 1,400 | 1,600 | 1,800 | 2,000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 14 44 | 15 38 | 16 29 | 17 21 | 18 13 | 26 16 | | | | | | | | | | | | |
| .2 | 7 30 | 7 57 | 8 25 | 8 53 | 9 20 | 13 52 | 18 13 | 22 21 | 26 16 | 29 56 | | | | | | | | |
| .3 | 5 01 | 5 19 | 5 38 | 5 57 | 6 15 | 9 20 | 12 22 | 15 20 | 18 13 | 21 00 | 23 41 | 26 16 | 28 44 | | | | | |
| .4 | 3 46 | 4 00 | 4 14 | 4 28 | 4 42 | 7 02 | 9 20 | 11 37 | 13 52 | 16 03 | 18 13 | 20 19 | 22 21 | 26 16 | 29 56 | | | |
| 0.5 | 3 01 | 3 12 | 3 23 | 3 35 | 3 46 | 5 38 | 7 30 | 9 20 | 11 10 | 12 58 | 14 45 | 16 29 | 18 13 | 21 32 | 24 44 | 27 46 | 30 38 | |
| .6 | 2 31 | 2 40 | 2 49 | 2 59 | 3 08 | 4 42 | 6 15 | 7 48 | 9 20 | 10 52 | 12 22 | 13 52 | 15 20 | 18 13 | 21 00 | 23 41 | 26 16 | 28 44 |
| .7 | 2 09 | 2 17 | 2 25 | 2 34 | 2 41 | 4 02 | 5 22 | 6 42 | 8 01 | 9 20 | 10 39 | 11 56 | 13 13 | 15 45 | 18 13 | 20 36 | 22 55 | 25 10 |
| .8 | 1 53 | 2 00 | 2 07 | 2 14 | 2 21 | 3 32 | 4 42 | 5 52 | 7 02 | 8 11 | 9 20 | 10 29 | 11 37 | 13 52 | 16 03 | 18 13 | 20 19 | 22 21 |
| .9 | 1 40 | 1 48 | 1 53 | 1 59 | 2 06 | 3 08 | 4 11 | 5 13 | 6 15 | 7 17 | 8 19 | 9 20 | 10 21 | 12 22 | 14 21 | 16 18 | 18 13 | 20 05 |
| 1.0 | 1 30 | 1 36 | 1 42 | 1 47 | 1 53 | 2 49 | 3 46 | 4 42 | 5 38 | 6 34 | 7 30 | 8 25 | 9 20 | 11 10 | 12 58 | 14 45 | 16 29 | 18 13 |
| .1 | 1 22 | 1 27 | 1 33 | 1 38 | 1 43 | 2 34 | 3 25 | 4 17 | 5 08 | 5 59 | 6 49 | 7 40 | 8 30 | 10 10 | 11 50 | 13 28 | 15 04 | 16 39 |
| .2 | 1 15 | 1 20 | 1 25 | 1 30 | 1 34 | 2 21 | 3 08 | 3 55 | 4 42 | 5 29 | 6 15 | 7 02 | 7 48 | 9 20 | 10 52 | 12 22 | 13 52 | 15 20 |
| .3 | 1 10 | 1 14 | 1 18 | 1 23 | 1 27 | 2 10 | 2 54 | 3 37 | 4 20 | 5 04 | 5 47 | 6 30 | 7 13 | 8 38 | 10 03 | 11 27 | 12 50 | 14 12 |
| .4 | 1 05 | 1 09 | 1 13 | 1 17 | 1 21 | 2 01 | 2 41 | 3 22 | 4 02 | 4 42 | 5 22 | 6 02 | 6 42 | 8 01 | 9 20 | 10 39 | 11 56 | 13 13 |
| 1.5 | 1 00 | 1 04 | 1 08 | 1 12 | 1 15 | 1 53 | 2 31 | 3 08 | 3 46 | 4 23 | 5 01 | 5 38 | 6 15 | 7 30 | 8 44 | 9 57 | 11 10 | 12 22 |
| .6 | 0 57 | 1 00 | 1 04 | 1 07 | 1 11 | 1 46 | 2 21 | 2 57 | 3 32 | 4 07 | 4 42 | 5 17 | 5 52 | 7 02 | 8 11 | 9 20 | 10 29 | 11 37 |
| .7 | 0 53 | 0 57 | 1 00 | 1 03 | 1 07 | 1 40 | 2 13 | 2 46 | 3 19 | 3 52 | 4 26 | 4 59 | 5 32 | 6 37 | 7 43 | 8 49 | 9 53 | 10 57 |
| .8 | 0 50 | 0 53 | 0 57 | 1 00 | 1 03 | 1 34 | 2 06 | 2 37 | 3 08 | 3 38 | 4 11 | 4 42 | 5 13 | 6 15 | 7 17 | 8 19 | 9 20 | 10 21 |
| .9 | 0 48 | 0 51 | 0 54 | 0 57 | 1 00 | 1 29 | 1 59 | 2 29 | 2 58 | 3 28 | 3 58 | 4 27 | 4 57 | 5 56 | 6 55 | 7 53 | 8 52 | 9 50 |
| 2.0 | 0 45 | 0 48 | 0 51 | 0 54 | 0 57 | 1 25 | 1 53 | 2 21 | 2 49 | 3 18 | 3 46 | 4 14 | 4 42 | 5 38 | 6 34 | 7 30 | 8 25 | 9 20 |
| .1 | 0 43 | 0 46 | 0 48 | 0 51 | 0 54 | 1 21 | 1 48 | 2 15 | 2 41 | 3 08 | 3 35 | 4 02 | 4 29 | 5 22 | 6 15 | 7 09 | 8 01 | 8 54 |
| .2 | 0 41 | 0 44 | 0 46 | 0 49 | 0 51 | 1 17 | 1 43 | 2 08 | 2 34 | 3 00 | 3 25 | 3 51 | 4 17 | 5 08 | 5 59 | 6 49 | 7 40 | 8 30 |
| .3 | 0 39 | 0 42 | 0 44 | 0 47 | 0 49 | 1 14 | 1 38 | 2 03 | 2 27 | 2 52 | 3 16 | 3 41 | 4 05 | 4 54 | 5 43 | 6 32 | 7 20 | 8 08 |
| .4 | 0 38 | 0 40 | 0 42 | 0 45 | 0 47 | 1 11 | 1 34 | 1 58 | 2 21 | 2 45 | 3 08 | 3 32 | 3 55 | 4 42 | 5 29 | 6 15 | 7 02 | 7 48 |
| 2.5 | 0 36 | 0 38 | 0 41 | 0 43 | 0 45 | 1 08 | 1 30 | 1 53 | 2 16 | 2 38 | 3 01 | 3 23 | 3 46 | 4 31 | 5 16 | 6 01 | 6 45 | 7 30 |
| .6 | 0 35 | 0 37 | 0 39 | 0 41 | 0 44 | 1 05 | 1 27 | 1 49 | 2 10 | 2 32 | 2 54 | 3 16 | 3 37 | 4 20 | 5 04 | 5 47 | 6 30 | 7 13 |
| .7 | 0 34 | 0 36 | 0 38 | 0 40 | 0 42 | 1 03 | 1 24 | 1 45 | 2 06 | 2 27 | 2 47 | 3 08 | 3 29 | 4 11 | 4 53 | 5 34 | 6 15 | 6 57 |
| .8 | 0 32 | 0 34 | 0 36 | 0 38 | 0 40 | 1 01 | 1 21 | 1 41 | 2 01 | 2 21 | 2 41 | 3 02 | 3 22 | 4 02 | 4 42 | 5 22 | 6 02 | 6 42 |
| .9 | 0 31 | 0 33 | 0 35 | 0 37 | 0 39 | 0 58 | 1 18 | 1 37 | 1 57 | 2 16 | 2 36 | 2 55 | 3 15 | 3 54 | 4 32 | 5 11 | 5 50 | 6 28 |
| 3.0 | 0 30 | 0 32 | 0 34 | 0 36 | 0 38 | 0 57 | 1 15 | 1 34 | 1 53 | 2 12 | 2 31 | 2 49 | 3 08 | 3 46 | 4 23 | 5 01 | 5 38 | 6 15 |
| .2 | 0 28 | 0 30 | 0 32 | 0 34 | 0 35 | 0 53 | 1 11 | 1 28 | 1 46 | 2 04 | 2 21 | 2 39 | 2 57 | 3 32 | 4 07 | 4 42 | 5 17 | 5 52 |
| .4 | 0 27 | 0 28 | 0 30 | 0 32 | 0 33 | 0 50 | 1 07 | 1 23 | 1 40 | 1 55 | 2 13 | 2 30 | 2 46 | 3 19 | 3 52 | 4 26 | 4 59 | 5 32 |
| .6 | 0 25 | 0 27 | 0 28 | 0 30 | 0 31 | 0 47 | 1 03 | 1 19 | 1 34 | 1 50 | 2 06 | 2 21 | 2 37 | 3 08 | 3 40 | 4 11 | 4 42 | 5 13 |
| .8 | 0 24 | 0 25 | 0 27 | 0 28 | 0 30 | 0 45 | 1 00 | 1 14 | 1 29 | 1 44 | 1 59 | 2 14 | 2 29 | 2 58 | 3 28 | 3 58 | 4 27 | 4 57 |
| 4.0 | 0 23 | 0 24 | 0 25 | 0 27 | 0 28 | 0 42 | 0 57 | 1 11 | 1 25 | 1 39 | 1 53 | 2 07 | 2 21 | 2 49 | 3 18 | 3 46 | 4 14 | 4 42 |
| .2 | 0 22 | 0 23 | 0 24 | 0 26 | 0 27 | 0 40 | 0 54 | 1 07 | 1 21 | 1 34 | 1 48 | 2 01 | 2 15 | 2 41 | 3 08 | 3 35 | 4 02 | 4 29 |
| .4 | 0 21 | 0 22 | 0 23 | 0 24 | 0 26 | 0 39 | 0 51 | 1 04 | 1 17 | 1 30 | 1 43 | 1 56 | 2 08 | 2 34 | 3 00 | 3 25 | 3 51 | 4 17 |
| .6 | 0 20 | 0 21 | 0 22 | 0 23 | 0 25 | 0 37 | 0 49 | 1 01 | 1 14 | 1 26 | 1 38 | 1 51 | 2 03 | 2 27 | 2 52 | 3 16 | 3 41 | 4 05 |
| .8 | 0 19 | 0 20 | 0 21 | 0 22 | 0 24 | 0 35 | 0 47 | 0 59 | 1 11 | 1 22 | 1 34 | 1 46 | 1 58 | 2 21 | 2 45 | 3 08 | 3 32 | 3 55 |
| 5.0 | 0 18 | 0 19 | 0 20 | 0 21 | 0 23 | 0 34 | 0 45 | 0 57 | 1 08 | 1 19 | 1 30 | 1 42 | 1 53 | 2 16 | 2 38 | 3 01 | 3 23 | 3 46 |

## TABLE 34.

For finding the distance of an object by an angle, measured from an elevated position, between the object and the horizon beyond.

| Dist., yards. | Height of the Eye Above the Level of the Sea, in Feet. | | | | | | | | | | | Dist., yards. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **20** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100** | **110** | **120** | |
| | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | |
| 100 | 3 44 | 5 37 | 7 29 | 9 21 | 11 11 | 13 00 | 14 47 | 16 34 | 18 16 | 19 58 | 21 37 | 100 |
| 200 | 1 50 | 2 46 | 3 43 | 4 39 | 5 35 | 6 31 | 7 27 | 8 23 | 9 18 | 10 13 | 11 08 | 200 |
| 300 | 1 12 | 1 49 | 2 26 | 3 04 | 3 41 | 4 19 | 4 56 | 5 33 | 6 11 | 6 48 | 7 25 | 300 |
| 400 | 52 | 1 21 | 1 48 | 2 16 | 2 44 | 3 12 | 3 40 | 4 08 | 4 36 | 5 04 | 5 32 | 400 |
| 500 | 41 | 1 03 | 1 25 | 1 48 | 2 10 | 2 32 | 2 54 | 3 17 | 3 39 | 4 01 | 4 24 | 500 |
| 600 | 34 | 52 | 1 10 | 1 29 | 1 47 | 2 05 | 2 24 | 2 42 | 3 01 | 3 20 | 3 38 | 600 |
| 700 | 28 | 44 | 1 01 | 1 15 | 1 31 | 1 46 | 2 01 | 2 18 | 2 34 | 2 50 | 3 05 | 700 |
| 800 | 24 | 38 | 51 | 1 05 | 1 18 | 1 32 | 1 46 | 2 00 | 2 13 | 2 27 | 2 41 | 800 |
| 900 | 21 | 33 | 45 | 57 | 1 09 | 1 22 | 1 33 | 1 45 | 1 57 | 2 10 | 2 22 | 900 |
| 1,000 | 18 | 29 | 40 | 50 | 1 01 | 1 12 | 1 23 | 1 34 | 1 45 | 1 56 | 2 07 | 1,000 |
| 1,100 | 16 | 26 | 35 | 45 | 55 | 1 05 | 1 15 | 1 24 | 1 34 | 1 44 | 1 54 | 1,100 |
| 1,200 | 15 | 23 | 32 | 41 | 50 | 59 | 1 08 | 1 17 | 1 26 | 1 35 | 1 44 | 1,200 |
| 1,300 | 13 | 21 | 29 | 37 | 45 | 53 | 1 02 | 1 10 | 1 18 | 1 27 | 1 35 | 1,300 |
| 1,400 | 12 | 19 | 27 | 34 | 41 | 49 | 57 | 1 04 | 1 12 | 1 20 | 1 27 | 1,400 |
| 1,500 | 11 | 18 | 24 | 31 | 38 | 45 | 52 | 59 | 1 07 | 1 14 | 1 21 | 1,500 |
| 1,600 | 10 | 16 | 22 | 29 | 35 | 42 | 48 | 55 | 1 02 | 1 08 | 1 15 | 1,600 |
| 1,700 | | 15 | 21 | 27 | 33 | 39 | 45 | 51 | 58 | 1 04 | 1 10 | 1,700 |
| 1,800 | | 14 | 19 | 25 | 31 | 36 | 42 | 48 | 54 | 1 00 | 1 06 | 1,800 |
| 1,900 | | 13 | 18 | 23 | 29 | 34 | 39 | 45 | 50 | 56 | 1 02 | 1,900 |
| 2,000 | | 12 | 17 | 22 | 27 | 32 | 37 | 42 | 47 | 53 | 58 | 2,000 |
| 2,100 | | 11 | 16 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 2,100 |
| 2,200 | | 10 | 15 | 19 | 24 | 28 | 33 | 38 | 42 | 47 | 52 | 2,200 |
| 2,300 | | | 14 | 18 | 22 | 27 | 31 | 36 | 40 | 45 | 49 | 2,300 |
| 2,400 | | | 13 | 17 | 21 | 25 | 29 | 34 | 38 | 42 | 47 | 2,400 |
| 2,500 | | | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 2,500 |
| 2,600 | | | 11 | 15 | 19 | 23 | 26 | 30 | 34 | 38 | 42 | 2,600 |
| 2,700 | | | 11 | 14 | 18 | 22 | 25 | 29 | 33 | 36 | 40 | 2,700 |
| 2,800 | | | 10 | 14 | 17 | 20 | 24 | 28 | 31 | 35 | 38 | 2,800 |
| 2,900 | | | | 13 | 16 | 19 | 23 | 26 | 30 | 33 | 37 | 2,900 |
| 3,000 | | | | 12 | 15 | 19 | 22 | 25 | 28 | 32 | 35 | 3,000 |
| 3,100 | | | | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 34 | 3,100 |
| 3,200 | | | | 11 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 3,200 |
| 3,300 | | | | 10 | 13 | 16 | 19 | 22 | 25 | 28 | 31 | 3,300 |
| 3,400 | | | | | 13 | 15 | 18 | 21 | 24 | 27 | 30 | 3,400 |
| 3,500 | | | | | 12 | 15 | 17 | 20 | 23 | 26 | 29 | 3,500 |
| 3,600 | | | | | 12 | 14 | 17 | 19 | 22 | 25 | 27 | 3,600 |
| 3,700 | | | | | 11 | 13 | 16 | 19 | 21 | 24 | 26 | 3,700 |
| 3,800 | | | | | 11 | 13 | 15 | 18 | 20 | 23 | 25 | 3,800 |
| 3,900 | | | | | 10 | 12 | 15 | 17 | 20 | 22 | 25 | 3,900 |
| 4,000 | | | | | | 12 | 14 | 16 | 19 | 21 | 24 | 4,000 |
| 4,100 | | | | | | 11 | 14 | 16 | 18 | 20 | 23 | 4,100 |
| 4,200 | | | | | | 11 | 13 | 15 | 17 | 20 | 22 | 4,200 |
| 4,300 | | | | | | 10 | 13 | 15 | 17 | 19 | 21 | 4,300 |
| 4,400 | | | | | | | 12 | 14 | 16 | 18 | 21 | 4,400 |
| 4,500 | | | | | | | 12 | 14 | 16 | 18 | 20 | 4,500 |
| 4,600 | | | | | | | 11 | 13 | 15 | 17 | 19 | 4,600 |
| 4,700 | | | | | | | 11 | 13 | 15 | 17 | 19 | 4,700 |
| 4,800 | | | | | | | 10 | 12 | 14 | 16 | 18 | 4,800 |
| 4,900 | | | | | | | | 12 | 14 | 15 | 17 | 4,900 |
| 5,000 | | | | | | | | 11 | 13 | 15 | 17 | 5,000 |

# TABLE 35.

Speed in knots per hour developed by a vessel traversing a measured nautical mile in any given number of minutes and seconds.

| Sec. | Number of minutes. | | | | | | | | | | | | Sec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| | Knots. | Knots. | Knots. | Knots. | Knots. | Knots. | Knots. | Knots. | Knots. | Knots. | Knots. | Knots. | |
| 0 | 60.000 | 30.000 | 20.000 | 15.000 | 12.000 | 10.000 | 8.571 | 7.500 | 6.666 | 6.000 | 5.455 | 5.000 | 0 |
| 1 | 59.016 | 29.752 | 19.890 | 14.938 | 11.960 | 9.972 | 8.551 | 7.484 | 6.654 | 5.990 | 5.446 | 4.993 | 1 |
| 2 | 58.065 | 29.508 | 19.780 | 14.876 | 11.920 | 9.944 | 8.530 | 7.468 | 6.642 | 5.980 | 5.438 | 4.986 | 2 |
| 3 | 57.143 | 29.268 | 19.672 | 14.815 | 11.880 | 9.917 | 8.510 | 7.453 | 6.629 | 5.970 | 5.429 | 4.979 | 3 |
| 4 | 56.250 | 29.032 | 19.565 | 14.754 | 11.841 | 9.890 | 8.490 | 7.438 | 6.617 | 5.960 | 5.421 | 4.972 | 4 |
| 5 | 55.385 | 28.800 | 19.460 | 14.694 | 11.803 | 9.863 | 8.470 | 7.422 | 6.605 | 5.950 | 5.413 | 4.965 | 5 |
| 6 | 54.545 | 28.571 | 19.355 | 14.634 | 11.764 | 9.836 | 8.450 | 7.407 | 6.593 | 5.940 | 5.405 | 4.958 | 6 |
| 7 | 53.731 | 28.346 | 19.251 | 14.575 | 11.726 | 9.809 | 8.430 | 7.392 | 6.581 | 5.930 | 5.397 | 4.951 | 7 |
| 8 | 52.941 | 28.125 | 19.149 | 14.516 | 11.688 | 9.783 | 8.411 | 7.377 | 6.569 | 5.921 | 5.389 | 4.945 | 8 |
| 9 | 52.174 | 27.907 | 19.048 | 14.458 | 11.650 | 9.756 | 8.392 | 7.362 | 6.557 | 5.911 | 5.381 | 4.938 | 9 |
| 10 | 51.429 | 27.692 | 18.947 | 14.400 | 11.613 | 9.729 | 8.372 | 7.346 | 6.545 | 5.902 | 5.373 | 4.932 | 10 |
| 11 | 50.704 | 27.481 | 18.848 | 14.342 | 11.575 | 9.703 | 8.353 | 7.331 | 6.533 | 5.892 | 5.365 | 4.924 | 11 |
| 12 | 50.000 | 27.273 | 18.750 | 14.286 | 11.538 | 9.677 | 8.334 | 7.317 | 6.521 | 5.882 | 5.357 | 4.918 | 12 |
| 13 | 49.315 | 27.068 | 18.652 | 14.229 | 11.501 | 9.651 | 8.315 | 7.302 | 6.509 | 5.872 | 5.349 | 4.911 | 13 |
| 14 | 48.649 | 26.866 | 18.556 | 14.173 | 11.465 | 9.625 | 8.295 | 7.287 | 6.498 | 5.863 | 5.341 | 4.904 | 14 |
| 15 | 48.000 | 26.667 | 18.461 | 14.118 | 11.428 | 9.600 | 8.276 | 7.272 | 6.486 | 5.853 | 5.333 | 4.897 | 15 |
| 16 | 47.368 | 26.471 | 18.367 | 14.063 | 11.392 | 9.574 | 8.257 | 7.258 | 6.474 | 5.844 | 5.325 | 4.891 | 16 |
| 17 | 46.753 | 26.277 | 18.274 | 14.008 | 11.356 | 9.549 | 8.238 | 7.243 | 6.463 | 5.834 | 5.317 | 4.884 | 17 |
| 18 | 46.154 | 26.087 | 18.182 | 13.953 | 11.321 | 9.524 | 8.219 | 7.229 | 6.451 | 5.825 | 5.309 | 4.878 | 18 |
| 19 | 45.570 | 25.899 | 18.090 | 13.900 | 11.285 | 9.499 | 8.200 | 7.214 | 6.440 | 5.815 | 5.301 | 4.871 | 19 |
| 20 | 45.000 | 25.714 | 18.000 | 13.846 | 11.250 | 9.473 | 8.181 | 7.200 | 6.428 | 5.806 | 5.294 | 4.865 | 20 |
| 21 | 44.444 | 25.532 | 17.910 | 13.793 | 11.214 | 9.448 | 8.163 | 7.185 | 6.417 | 5.797 | 5.286 | 4.858 | 21 |
| 22 | 43.902 | 25.352 | 17.822 | 13.740 | 11.180 | 9.424 | 8.144 | 7.171 | 6.405 | 5.787 | 5.278 | 4.851 | 22 |
| 23 | 43.373 | 25.175 | 17.734 | 13.688 | 11.146 | 9.399 | 8.126 | 7.157 | 6.394 | 5.778 | 5.270 | 4.845 | 23 |
| 24 | 42.857 | 25.000 | 17.647 | 13.636 | 11.111 | 9.375 | 8.108 | 7.142 | 6.383 | 5.769 | 5.263 | 4.838 | 24 |
| 25 | 42.353 | 24.828 | 17.560 | 13.584 | 11.077 | 9.350 | 8.090 | 7.128 | 6.371 | 5.760 | 5.255 | 4.832 | 25 |
| 26 | 41.860 | 24.658 | 17.475 | 13.533 | 11.043 | 9.326 | 8.071 | 7.114 | 6.360 | 5.750 | 5.247 | 4.825 | 26 |
| 27 | 41.379 | 24.490 | 17.391 | 13.483 | 11.009 | 9.302 | 8.053 | 7.100 | 6.349 | 5.741 | 5.240 | 4.819 | 27 |
| 28 | 40.909 | 24.324 | 17.307 | 13.433 | 10.975 | 9.278 | 8.035 | 7.086 | 6.338 | 5.732 | 5.232 | 4.812 | 28 |
| 29 | 40.449 | 24.161 | 17.225 | 13.383 | 10.942 | 9.254 | 8.017 | 7.072 | 6.327 | 5.723 | 5.224 | 4.806 | 29 |
| 30 | 40.000 | 24.000 | 17.143 | 13.333 | 10.909 | 9.230 | 8.000 | 7.059 | 6.315 | 5.714 | 5.217 | 4.800 | 30 |
| 31 | 39.560 | 23.841 | 17.061 | 13.284 | 10.876 | 9.207 | 7.982 | 7.045 | 6.304 | 5.705 | 5.210 | 4.793 | 31 |
| 32 | 39.130 | 23.684 | 16.981 | 13.235 | 10.843 | 9.183 | 7.964 | 7.031 | 6.293 | 5.696 | 5.202 | 4.787 | 32 |
| 33 | 38.710 | 23.529 | 16.901 | 13.186 | 10.810 | 9.160 | 7.947 | 7.017 | 6.282 | 5.687 | 5.195 | 4.780 | 33 |
| 34 | 38.298 | 23.377 | 16.822 | 13.138 | 10.778 | 9.137 | 7.929 | 7.004 | 6.271 | 5.678 | 5.187 | 4.774 | 34 |
| 35 | 37.895 | 23.226 | 16.744 | 13.091 | 10.746 | 9.113 | 7.912 | 6.990 | 6.260 | 5.669 | 5.179 | 4.768 | 35 |
| 36 | 37.500 | 23.077 | 16.667 | 13.043 | 10.714 | 9.090 | 7.895 | 6.977 | 6.250 | 5.660 | 5.172 | 4.761 | 36 |
| 37 | 37.113 | 22.930 | 16.590 | 12.996 | 10.682 | 9.068 | 7.877 | 6.963 | 6.239 | 5.651 | 5.164 | 4.755 | 37 |
| 38 | 36.735 | 22.785 | 16.514 | 12.950 | 10.651 | 9.045 | 7.860 | 6.950 | 6.228 | 5.642 | 5.157 | 4.749 | 38 |
| 39 | 36.364 | 22.642 | 16.438 | 12.903 | 10.619 | 9.022 | 7.843 | 6.936 | 6.217 | 5.633 | 5.150 | 4.743 | 39 |
| 40 | 36.000 | 22.500 | 16.363 | 12.857 | 10.588 | 9.000 | 7.826 | 6.923 | 6.207 | 5.625 | 5.143 | 4.737 | 40 |
| 41 | 35.644 | 22.360 | 16.289 | 12.811 | 10.557 | 8.977 | 7.809 | 6.909 | 6.196 | 5.616 | 5.135 | 4.731 | 41 |
| 42 | 35.294 | 22.222 | 16.216 | 12.766 | 10.526 | 8.955 | 7.792 | 6.896 | 6.185 | 5.607 | 5.128 | 4.724 | 42 |
| 43 | 34.951 | 22.086 | 16.143 | 12.721 | 10.495 | 8.933 | 7.775 | 6.883 | 6.174 | 5.598 | 5.121 | 4.718 | 43 |
| 44 | 34.615 | 21.951 | 16.071 | 12.676 | 10.465 | 8.911 | 7.758 | 6.870 | 6.164 | 5.590 | 5.114 | 4.712 | 44 |
| 45 | 34.286 | 21.818 | 16.000 | 12.631 | 10.434 | 8.889 | 7.741 | 6.857 | 6.153 | 5.581 | 5.106 | 4.706 | 45 |
| 46 | 33.962 | 21.687 | 15.929 | 12.587 | 10.404 | 8.867 | 7.725 | 6.844 | 6.143 | 5.572 | 5.099 | 4.700 | 46 |
| 47 | 33.645 | 21.557 | 15.859 | 12.543 | 10.375 | 8.845 | 7.708 | 6.831 | 6.132 | 5.564 | 5.091 | 4.693 | 47 |
| 48 | 33.333 | 21.429 | 15.789 | 12.500 | 10.345 | 8.823 | 7.692 | 6.818 | 6.122 | 5.555 | 5.084 | 4.687 | 48 |
| 49 | 33.028 | 21.302 | 15.721 | 12.456 | 10.315 | 8.801 | 7.675 | 6.805 | 6.112 | 5.547 | 5.077 | 4.681 | 49 |
| 50 | 32.727 | 21.176 | 15.652 | 12.413 | 10.286 | 8.780 | 7.659 | 6.792 | 6.101 | 5.538 | 5.070 | 4.675 | 50 |
| 51 | 32.432 | 21.053 | 15.584 | 12.371 | 10.256 | 8.759 | 7.643 | 6.779 | 6.091 | 5.530 | 5.063 | 4.669 | 51 |
| 52 | 32.143 | 20.930 | 15.517 | 12.329 | 10.227 | 8.737 | 7.627 | 6.766 | 6.081 | 5.521 | 5.056 | 4.663 | 52 |
| 53 | 31.858 | 20.809 | 15.450 | 12.287 | 10.198 | 8.716 | 7.611 | 6.754 | 6.071 | 5.513 | 5.049 | 4.657 | 53 |
| 54 | 31.579 | 20.690 | 15.384 | 12.245 | 10.169 | 8.695 | 7.595 | 6.741 | 6.060 | 5.504 | 5.042 | 4.651 | 54 |
| 55 | 31.304 | 20.571 | 15.319 | 12.203 | 10.140 | 8.675 | 7.579 | 6.739 | 6.050 | 5.496 | 5.035 | 4.645 | 55 |
| 56 | 31.034 | 20.455 | 15.254 | 12.162 | 10.112 | 8.654 | 7.563 | 6.716 | 6.040 | 5.487 | 5.028 | 4.639 | 56 |
| 57 | 30.769 | 20.339 | 15.190 | 12.121 | 10.084 | 8.633 | 7.547 | 6.704 | 6.030 | 5.479 | 5.020 | 4.633 | 57 |
| 58 | 30.508 | 20.225 | 15.126 | 12.080 | 10.055 | 8.612 | 7.531 | 6.691 | 6.020 | 5.471 | 5.013 | 4.627 | 58 |
| 59 | 30.252 | 20.112 | 15.062 | 12.040 | 10.027 | 8.591 | 7.515 | 6.679 | 6.010 | 5.463 | 5.006 | 4.621 | 59 |
| Sec. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Sec. |

TABLE 36.

Reduction of Local Mean Time to Standard Meridian Time, and the reverse.

[If local meridian is east of standard meridian, subtract from local mean time, or add to standard meridian time. If local meridian is west of standard meridian, add to local mean time, or subtract from standard meridian time.]

| Difference of longitude between local meridian and standard meridian. | Reduction to be applied to local mean time. | Difference of longitude between local meridian and standard meridian. | Reduction to be applied to local mean time. |
|---|---|---|---|
| ° ′    ° ′ | Minutes. | ° ′    ° ′ | Minutes. |
| 0 00 to 0 07 | 0 | 7 23 to  7 37 | 30 |
| 0 08 to 0 22 | 1 | 7 38 to  7 52 | 31 |
| 0 23 to 0 37 | 2 | 7 53 to  8 07 | 32 |
| 0 38 to 0 52 | 3 | 8 08 to  8 22 | 33 |
| 0 53 to 1 07 | 4 | 8 23 to  8 37 | 34 |
| 1 08 to 1 22 | 5 | 8 38 to  8 52 | 35 |
| 1 23 to 1 37 | 6 | 8 53 to  9 07 | 36 |
| 1 38 to 1 52 | 7 | 9 08 to  9 22 | 37 |
| 1 53 to 2 07 | 8 | 9 23 to  9 37 | 38 |
| 2 08 to 2 22 | 9 | 9 38 to  9 52 | 39 |
| 2 23 to 2 37 | 10 | 9 53 to 10 07 | 40 |
| 2 38 to 2 52 | 11 | 10 08 to 10 22 | 41 |
| 2 53 to 3 07 | 12 | 10 23 to 10 37 | 42 |
| 3 08 to 3 22 | 13 | 10 38 to 10 52 | 43 |
| 3 23 to 3 37 | 14 | 10 53 to 11 07 | 44 |
| 3 38 to 3 52 | 15 | 11 08 to 11 22 | 45 |
| 3 53 to 4 07 | 16 | 11 23 to 11 37 | 46 |
| 4 08 to 4 22 | 17 | 11 38 to 11 52 | 47 |
| 4 23 to 4 37 | 18 | 11 53 to 12 07 | 48 |
| 4 38 to 4 52 | 19 | 12 08 to 12 22 | 49 |
| 4 53 to 5 07 | 20 | 12 23 to 12 37 | 50 |
| 5 08 to 5 22 | 21 | 12 38 to 12 52 | 51 |
| 5 23 to 5 37 | 22 | 12 53 to 13 07 | 52 |
| 5 38 to 5 52 | 23 | 13 08 to 13 22 | 53 |
| 5 53 to 6 07 | 24 | 13 23 to 13 37 | 54 |
| 6 08 to 6 22 | 25 | 13 38 to 13 52 | 55 |
| 6 23 to 6 37 | 26 | 13 53 to 14 07 | 56 |
| 6 38 to 6 52 | 27 | 14 08 to 14 22 | 57 |
| 6 53 to 7 07 | 28 | 14 23 to 14 37 | 58 |
| 7 08 to 7 22 | 29 | 14 38 to 14 52 | 59 |

## TABLE 37. [Page 571

### Log. A and Log. B.

[For Computing the Equation of Equal Altitudes.   For Noon, A−; for Midnight, A+; for Noon or Midnight, B+.
Argument=Elapsed Time.]

| Elapsed time. | 0h | | 1h | | 2h | | 3h | | 4h | | 5h | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| m. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. |
| 0 | 9.4059 | 9.4059 | 9.4072 | 9.4034 | 9.4109 | 9.3959 | 9.4172 | 9.3828 | 9.4260 | 9.3635 | 9.4374 | 9.3369 |
| 1 | .4059 | .4059 | .4072 | .4034 | .4110 | .3957 | .4173 | .3825 | .4261 | .3631 | .4376 | .3364 |
| 2 | .4059 | .4059 | .4073 | .4033 | .4111 | .3955 | .4174 | .3822 | .4263 | .3627 | .4378 | .3358 |
| 3 | .4059 | .4059 | .4073 | .4032 | .4112 | .3953 | .4175 | .3820 | .4265 | .3624 | .4380 | .3353 |
| 4 | .4059 | .4059 | .4074 | .4031 | .4113 | .3952 | .4177 | .3817 | .4266 | .3620 | .4383 | .3348 |
| 5 | 9.4059 | 9.4059 | 9.4074 | 9.4030 | 9.4113 | 9.3950 | 9.4178 | 9.3814 | 9.4268 | 9.3616 | 9.4385 | 9.3343 |
| 6 | .4060 | .4059 | .4074 | .4029 | .4114 | .3948 | .4179 | .3811 | .4270 | .3612 | .4387 | .3337 |
| 7 | .4060 | .4059 | .4075 | .4028 | .4115 | .3946 | .4181 | .3809 | .4272 | .3608 | .4389 | .3332 |
| 8 | .4060 | .4059 | .4075 | .4027 | .4116 | .3944 | .4182 | .3806 | .4273 | .3604 | .4391 | .3327 |
| 9 | .4060 | .4059 | .4076 | .4026 | .4117 | .3943 | .4183 | .3803 | .4275 | .3600 | .4393 | .3221 |
| 10 | 9.4060 | 9.4059 | 9.4076 | 9.4025 | 9.4118 | 9.3941 | 9.4184 | 9.3800 | 9.4277 | 9.3596 | 9.4396 | 9.3316 |
| 11 | .4060 | .4059 | .4077 | .4024 | .4119 | .3939 | .4186 | .3797 | .4279 | .3592 | .4398 | .3311 |
| 12 | .4060 | .4058 | .4077 | .4023 | .4120 | .3937 | .4187 | .3794 | .4280 | .3588 | .4400 | .3305 |
| 13 | .4060 | .4058 | .4078 | .4022 | .4121 | .3935 | .4188 | .3792 | .4282 | .3584 | .4402 | .3300 |
| 14 | .4060 | .4058 | .4078 | .4021 | .4121 | .3933 | .4190 | .3789 | .4284 | .3580 | .4405 | .3294 |
| 15 | 9.4060 | 9.4058 | 9.4079 | 9.4020 | 9.4122 | 9.3931 | 9.4191 | 9.3786 | 9.4286 | 9.3576 | 9.4407 | 9.3289 |
| 16 | .4060 | .4058 | .4079 | .4019 | .4123 | .3929 | .4193 | .3783 | .4288 | .3572 | .4409 | .3283 |
| 17 | .4060 | .4057 | .4080 | .4018 | .4124 | .3927 | .4194 | .3780 | .4289 | .3568 | .4411 | .3278 |
| 18 | .4061 | .4057 | .4080 | .4017 | .4125 | .3925 | .4195 | .3777 | .4291 | .3564 | .4414 | .3272 |
| 19 | .4061 | .4057 | .4081 | .4016 | .4126 | .3923 | .4197 | .3774 | .4293 | .3559 | .4416 | .3266 |
| 20 | 9.4061 | 9.4057 | 9.4081 | 9.4015 | 9.4127 | 9.3921 | 9.4198 | 9.3771 | 9.4295 | 9.3555 | 9.4418 | 9.3261 |
| 21 | .4061 | .4056 | .4082 | .4014 | .4128 | .3919 | .4199 | .3768 | .4297 | .3551 | .4420 | .3255 |
| 22 | .4061 | .4056 | .4083 | .4013 | .4129 | .3917 | .4201 | .3765 | .4299 | .3547 | .4423 | .3249 |
| 23 | .4061 | .4056 | .4083 | .4012 | .4130 | .3915 | .4202 | .3762 | .4300 | .3542 | .4425 | .3244 |
| 24 | .4061 | .4055 | .4084 | .4010 | .4131 | .3913 | .4204 | .3759 | .4302 | .3538 | .4427 | .3238 |
| 25 | 9.4062 | 9.4055 | 9.4084 | 9.4009 | 9.4132 | 9.3911 | 9.4205 | 9.3756 | 9.4304 | 9.3534 | 9.4430 | 9.3232 |
| 26 | .4062 | .4055 | .4085 | .4008 | .4133 | .3909 | .4207 | .3752 | .4306 | .3530 | .4432 | .3226 |
| 27 | .4062 | .4054 | .4086 | .4007 | .4134 | .3907 | .4208 | .3749 | .4308 | .3525 | .4434 | .3220 |
| 28 | .4062 | .4054 | .4086 | .4006 | .4135 | .3905 | .4209 | .3746 | .4310 | .3521 | .4437 | .3214 |
| 29 | .4062 | .4054 | .4087 | .4004 | .4136 | .3903 | .4211 | .3743 | .4312 | .3516 | .4439 | .3208 |
| 30 | 9.4062 | 9.4053 | 9.4087 | 9.4003 | 9.4137 | 9.3900 | 9.4212 | 9.3740 | 9.4314 | 9.3512 | 9.4441 | 9.3203 |
| 31 | .4063 | .4053 | .4088 | .4002 | .4138 | .3898 | .4214 | .3737 | .4315 | .3508 | .4444 | .3197 |
| 32 | .4063 | .4052 | .4089 | .4001 | .4139 | .3896 | .4215 | .3733 | .4317 | .3503 | .4446 | .3191 |
| 33 | .4063 | .4052 | .4089 | .3999 | .4140 | .3894 | .4217 | .3730 | .4319 | .3499 | .4448 | .3185 |
| 34 | .4063 | .4051 | .4090 | .3998 | .4141 | .3892 | .4218 | .3727 | .4321 | .3494 | .4451 | .3178 |
| 35 | 9.4064 | 9.4051 | 9.4091 | 9.3997 | 9.4142 | 9.3889 | 9.4220 | 9.3723 | 9.4323 | 9.3490 | 9.4453 | 9.3172 |
| 36 | .4064 | .4050 | .4091 | .3995 | .4144 | .3887 | .4221 | .3720 | .4325 | .3485 | .4456 | .3166 |
| 37 | .4064 | .4050 | .4092 | .3994 | .4145 | .3885 | .4223 | .3717 | .4327 | .3480 | .4458 | .3160 |
| 38 | .4064 | .4049 | .4093 | .3993 | .4146 | .3882 | .4224 | .3713 | .4329 | .3476 | .4460 | .3154 |
| 39 | .4065 | .4049 | .4093 | .3991 | .4147 | .3880 | .4226 | .3710 | .4331 | .3471 | .4463 | .3148 |
| 40 | 9.4065 | 9.4048 | 9.4094 | 9.3990 | 9.4148 | 9.3878 | 9.4227 | 9.3707 | 9.4333 | 9.3467 | 9.4465 | 9.3142 |
| 41 | .4065 | .4048 | .4095 | .3988 | .4149 | .3875 | .4229 | .3703 | .4335 | .3462 | .4468 | .3135 |
| 42 | .4065 | .4047 | .4095 | .3987 | .4150 | .3873 | .4231 | .3700 | .4337 | .3457 | .4470 | .3129 |
| 43 | .4066 | .4047 | .4096 | .3985 | .4151 | .3871 | .4232 | .3696 | .4339 | .3453 | .4473 | .3123 |
| 44 | .4066 | .4046 | .4097 | .3984 | .4152 | .3868 | .4234 | .3693 | .4341 | .3448 | .4475 | .3116 |
| 45 | 9.4066 | 9.4045 | 9.4097 | 9.3982 | 9.4154 | 9.3866 | 9.4235 | 9.3690 | 9.4343 | 9.3443 | 9.4477 | 9.3110 |
| 46 | .4067 | .4045 | .4098 | .3981 | .4155 | .3863 | .4237 | .3686 | .4345 | .3438 | .4480 | .3103 |
| 47 | .4067 | .4044 | .4099 | .3979 | .4156 | .3861 | .4238 | .3683 | .4347 | .3433 | .4482 | .3097 |
| 48 | .4067 | .4043 | .4100 | .3978 | .4157 | .3859 | .4240 | .3679 | .4349 | .3429 | .4485 | .3091 |
| 49 | .4068 | .4043 | .4100 | .3976 | .4158 | .3856 | .4242 | .3675 | .4351 | .3424 | .4487 | .3084 |
| 50 | 9.4068 | 9.4042 | 9.4101 | 9.3975 | 9.4159 | 9.3854 | 9.4243 | 9.3672 | 9.4353 | 9.3419 | 9.4490 | 9.3078 |
| 51 | .4068 | .4041 | .4102 | .3973 | .4161 | .3851 | .4245 | .3668 | .4355 | .3414 | .4492 | .3071 |
| 52 | .4069 | .4041 | .4103 | .3972 | .4162 | .3849 | .4246 | .3665 | .4357 | .3409 | .4494 | .3064 |
| 53 | .4069 | .4040 | .4103 | .3970 | .4163 | .3846 | .4248 | .3661 | .4359 | .3404 | .4497 | .3058 |
| 54 | .4069 | .4039 | .4104 | .3969 | .4164 | .3843 | .4250 | .3657 | .4361 | .3399 | .4500 | .3051 |
| 55 | 9.4070 | 9.4038 | 9.4105 | 9.3967 | 9.4165 | 9.3841 | 9.4251 | 9.3654 | 9.4363 | 9.3394 | 9.4503 | 9.3044 |
| 56 | .4070 | .4038 | .4106 | .3965 | .4167 | .3838 | .4253 | .3650 | .4366 | .3389 | .4505 | .3038 |
| 57 | .4071 | .4037 | .4107 | .3964 | .4168 | .3836 | .4255 | .3646 | .4368 | .3384 | .4508 | .3031 |
| 58 | .4071 | .4036 | .4107 | .3962 | .4169 | .3833 | .4256 | .3643 | .4370 | .3379 | .4510 | .3024 |
| 59 | .4071 | .4035 | .4108 | .3960 | .4170 | .3830 | .4258 | .3639 | .4372 | .3374 | .4513 | .3017 |
| 60 | 9.4072 | 9.4034 | 9.4109 | 9.3959 | 9.4172 | 9.3828 | 9.4260 | 9.3635 | 9.4374 | 9.3369 | 9.4515 | 9.3010 |

# TABLE 37.

## Log. A and Log. B.

[For Computing the Equation of Equal Altitudes. For Noon, A−; for Midnight, A+; for Noon or Midnight, B+. Argument=Elapsed Time.]

| Elapsed time | 6h | | 7h | | 8h | | 9h | | 10h | | 11h | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. |
| m. | | | | | | | | | | | | |
| 0 | 9.4515 | 9.3010 | 9.4685 | 9.2530 | 9.4884 | 9.1874 | 9.5115 | 9.0943 | 9.5379 | 8.9509 | 9.5680 | 8.6837 |
| 1 | .4518 | .3003 | .4688 | .2520 | .4888 | .1861 | .5119 | .0925 | .5384 | .9478 | 5685 | .6770 |
| 2 | .4521 | .2996 | .4691 | .2511 | .4892 | .1848 | .5123 | .0906 | .5389 | .9447 | 5691 | .6701 |
| 3 | .4523 | .2989 | .4694 | .2502 | .4895 | .1835 | .5127 | .0887 | .5393 | .9416 | 5696 | .6632 |
| 4 | .4526 | .2982 | .4697 | .2492 | .4899 | .1822 | .5132 | .0867 | .5398 | .9384 | .5701 | .6560 |
| 5 | 9.4528 | 9.2975 | 9.4701 | 9.2483 | 9.4902 | 9.1809 | 9.5136 | 9.0848 | 9.5403 | 8.9352 | 9.5707 | 8.6488 |
| 6 | .4531 | .2968 | .4704 | .2473 | .4906 | .1796 | .5140 | .0828 | .5408 | .9320 | .5712 | .6414 |
| 7 | .4534 | .2961 | .4707 | .2463 | .4910 | .1782 | .5144 | .0809 | .5412 | .9287 | .5718 | .6339 |
| 8 | .4536 | .2954 | .4710 | .2454 | .4913 | .1769 | .5148 | .0789 | .5417 | .9254 | .5723 | .6262 |
| 9 | .4539 | .2947 | .4713 | .2444 | .4917 | .1756 | .5153 | .0769 | .5422 | .9221 | .5728 | .6183 |
| 10 | 9.4542 | 9.2940 | 9.4716 | 9.2434 | 9.4921 | 9.1742 | 9.5157 | 9.0749 | 9.5427 | 8.9187 | 9.5734 | 8.6103 |
| 11 | .4544 | .2932 | .4719 | .2425 | .4924 | .1728 | .5161 | .0729 | .5432 | .9153 | .5739 | .6021 |
| 12 | .4547 | .2925 | .4723 | .2415 | .4928 | .1715 | .5165 | .0708 | .5436 | .9118 | .5745 | .5937 |
| 13 | .4550 | .2918 | .4726 | .2405 | .4932 | .1701 | .5169 | .0688 | .5441 | .9083 | .5750 | .5852 |
| 14 | .4552 | .2911 | .4729 | .2395 | .4935 | .1687 | .5174 | .0667 | .5446 | .9048 | .5756 | .5764 |
| 15 | 9.4555 | 9.2903 | 9.4732 | 9.2385 | 9.4939 | 9.1673 | 9.5178 | 9.0646 | 9.5451 | 8.9013 | 9.5761 | 8.5674 |
| 16 | .4558 | .2896 | .4735 | .2375 | .4943 | .1659 | .5182 | .0625 | .5456 | .8977 | .5767 | .5583 |
| 17 | .4561 | .2888 | .4738 | .2365 | .4946 | .1645 | .5186 | .0604 | .5461 | .8940 | .5772 | .5488 |
| 18 | .4563 | .2881 | .4742 | .2355 | .4950 | .1630 | .5191 | .0583 | .5466 | .8903 | .5778 | .5392 |
| 19 | .4566 | .2873 | .4745 | .2344 | .4954 | .1616 | .5195 | .0561 | .5470 | .8866 | .5783 | .5293 |
| 20 | 9.4569 | 9.2866 | 9.4748 | 9.2334 | 9.4958 | 9.1602 | 9.5199 | 9.0540 | 9.5475 | 8.8829 | 9.5789 | 8.5192 |
| 21 | .4572 | .2858 | .4751 | .2324 | .4961 | .1587 | .5204 | .0518 | .5480 | .8791 | .5794 | .5088 |
| 22 | .4574 | .2850 | .4755 | .2313 | .4965 | .1573 | .5208 | .0496 | .5485 | .8752 | .5800 | .4981 |
| 23 | .4577 | .2843 | .4758 | .2303 | .4969 | .1558 | .5212 | .0474 | .5490 | .8713 | .5806 | .4871 |
| 24 | .4580 | .2835 | .4761 | .2292 | .4973 | .1543 | .5217 | .0452 | .5495 | .8674 | .5811 | .4758 |
| 25 | 9.4583 | 9.2827 | 9.4764 | 9.2282 | 9.4977 | 9.1528 | 9.5221 | 9.0429 | 9.5500 | 8.8634 | 9.5817 | 8.4641 |
| 26 | .4585 | .2819 | .4768 | .2271 | .4980 | .1513 | .5225 | .0406 | .5505 | .8594 | .5822 | .4521 |
| 27 | .4588 | .2812 | .4771 | .2261 | .4984 | .1498 | .5230 | .0383 | .5510 | .8553 | .5828 | .4397 |
| 28 | .4591 | .2804 | .4774 | .2250 | .4988 | .1483 | .5234 | .0360 | .5515 | .8512 | .5834 | .4270 |
| 29 | .4594 | .2796 | .4778 | .2239 | .4992 | .1468 | .5238 | .0337 | .5520 | .8470 | .5839 | .4138 |
| 30 | 9.4597 | 9.2788 | 9.4781 | 9.2228 | 9.4996 | 9.1453 | 9.5243 | 9.0314 | 9.5525 | 8.8427 | 9.5845 | 8.4001 |
| 31 | .4600 | .2780 | .4784 | .2217 | .5000 | .1437 | .5247 | .0290 | .5530 | .8384 | .5851 | .3860 |
| 32 | .4602 | .2772 | .4788 | .2206 | .5003 | .1422 | .5252 | .0266 | .5535 | .8341 | .5856 | .3713 |
| 33 | .4605 | .2764 | .4791 | .2195 | .5007 | .1406 | .5256 | .0242 | .5540 | .8297 | .5862 | .3561 |
| 34 | .4608 | .2756 | .4794 | .2184 | .5011 | .1390 | 5261 | .0218 | .5545 | .8253 | .5868 | .3403 |
| 35 | 9.4611 | 9.2747 | 9.4798 | 9.2173 | 9.5015 | 9.1375 | 9.5265 | 9.0194 | 9.5550 | 8.8208 | 9.5874 | 8.3239 |
| 36 | .4614 | .2739 | .4801 | .2162 | .5019 | .1359 | .5269 | .0169 | .5555 | .8162 | .5879 | .3067 |
| 37 | .4617 | .2731 | .4804 | .2151 | .5023 | .1343 | .5274 | .0144 | .5560 | .8115 | .5885 | .2888 |
| 38 | .4620 | .2723 | .4808 | .2140 | .5027 | .1327 | .5278 | .0119 | .5565 | .8068 | .5891 | .2701 |
| 39 | .4622 | .2714 | .4811 | .2128 | .5031 | .1310 | .5283 | .0094 | .5570 | .8020 | .5897 | .2505 |
| 40 | 9.4625 | 9.2706 | 9.4815 | 9.2117 | 9.5035 | 9.1294 | 9.5287 | 9.0069 | 9.5576 | 8.7972 | 9.5902 | 8.2299 |
| 41 | .4628 | .2698 | .4818 | .2105 | .5038 | .1278 | .5292 | .0043 | .5581 | .7923 | .5908 | .2082 |
| 42 | .4631 | .2689 | .4821 | .2094 | .5042 | .1261 | .5296 | .0017 | .5586 | .7873 | .5914 | .1853 |
| 43 | .4634 | .2681 | .4825 | .2082 | .5046 | .1244 | .5301 | 8.9991 | .5591 | .7823 | .5920 | .1611 |
| 44 | .4637 | .2672 | .4828 | .2070 | .5050 | .1228 | .5305 | .9965 | .5596 | .7772 | .5926 | .1354 |
| 45 | 9.4640 | 9.2664 | 9.4832 | 9.2059 | 9.5054 | 9.1211 | 9.5310 | 8.9938 | 9.5601 | 8.7720 | 9.5931 | 8.1080 |
| 46 | .4643 | .2655 | .4835 | .2047 | .5058 | .1194 | .5315 | .9911 | .5606 | .7668 | .5937 | .0786 |
| 47 | .4646 | .2646 | .4839 | .2035 | .5062 | .1177 | .5319 | .9884 | .5612 | .7614 | .5943 | .0470 |
| 48 | .4649 | .2638 | .4842 | .2023 | .5066 | .1159 | .5324 | .9857 | .5617 | .7560 | .5949 | .0128 |
| 49 | .4652 | .2629 | .4846 | .2011 | .5070 | .1142 | .5328 | .9830 | .5622 | .7505 | .5955 | 7.9756 |
| 50 | 9.4655 | 9.2620 | 9.4849 | 9.1999 | 9.5074 | 9.1125 | 9.5333 | 8.9802 | 9.5627 | 8.7449 | 9.5961 | 7.9348 |
| 51 | .4658 | .2611 | .4853 | .1987 | .5078 | .1107 | .5337 | .9774 | .5632 | .7392 | .5967 | .8897 |
| 52 | .4661 | .2602 | .4856 | .1974 | .5082 | .1089 | .5342 | .9745 | .5638 | .7335 | .5973 | .8391 |
| 53 | .4664 | .2593 | .4860 | .1962 | .5086 | .1072 | .5347 | .9717 | .5643 | .7276 | .5979 | .7817 |
| 54 | .4667 | .2584 | .4863 | .1950 | .5091 | .1054 | .5351 | .9688 | .5648 | .7217 | .5985 | .7154 |
| 55 | 9.4670 | 9.2575 | 9.4867 | 9.1937 | 9.5095 | 9.1036 | 9.5356 | 8.9659 | 9.5654 | 8.7156 | 9.5991 | 7.6368 |
| 56 | .4673 | .2566 | .4870 | .1925 | .5099 | .1017 | .5361 | .9630 | .5659 | .7094 | .5997 | .5405 |
| 57 | .4676 | .2557 | .4874 | .1912 | .5103 | .0999 | .5365 | .9600 | .5664 | .7032 | .6003 | .4162 |
| 58 | .4679 | .2548 | .4877 | .1900 | .5107 | .0981 | .5370 | .9570 | .5669 | .6968 | .6009 | .2407 |
| 59 | .4682 | .2539 | .4881 | .1887 | .5111 | .0962 | .5375 | .9540 | .5675 | .6903 | .6015 | 6.9591 |
| 60 | 9.4685 | 9.2530 | 9.4884 | 9.1874 | 9.5115 | 9.0943 | 9.5379 | 8.9509 | 9.5680 | 8.6837 | 9.6021 | *Inf.* |

TABLE 37. [Page 573

## Log. A and Log. B.

[For Computing the Equation of Equal Altitudes. For Noon, A —; for Midnight, A +; for Noon or Midnight, B —.
Argument = Elapsed Time.]

| Elapsed time | 12h | | 13h | | 14h | | 15h | | 16h | | 17h | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. |
| m. | | | | | | | | | | | | |
| 0 | 9.6021 | Inf. | 9.6406 | 8.7563 | 9.6841 | 9.0971 | 9.7333 | 9.3162 | 9.7895 | 9.4884 | 9.8539 | 9.6383 |
| 1 | .6027 | 6.9603 | .6412 | .7641 | .6848 | .1014 | .7342 | .3194 | .7905 | .4911 | .8550 | .6407 |
| 2 | .6033 | 7.2431 | .6419 | .7718 | .6856 | .1057 | .7351 | .3225 | .7915 | .4937 | .8562 | .6431 |
| 3 | .6039 | .4198 | .6426 | .7794 | .6864 | .1099 | .7360 | .3256 | .7925 | .4963 | .8573 | .6455 |
| 4 | .6045 | .5453 | .6433 | .7868 | .6872 | .1141 | .7369 | .3287 | .7935 | .4990 | .8585 | .6478 |
| 5 | 9.6051 | 7.6428 | 9.6440 | 8.7942 | 9.6879 | 9.1183 | 9.7378 | 9.3319 | 9.7945 | 9.5016 | 9.8597 | 9.6502 |
| 6 | .6057 | .7226 | .6447 | .8015 | .6887 | .1224 | .7386 | .3350 | .7955 | .5042 | .8608 | .6526 |
| 7 | .6063 | .7902 | .6454 | .8087 | .6895 | .1265 | .7395 | .3380 | .7965 | .5068 | .8620 | .6550 |
| 8 | .6069 | .8488 | .6461 | .8158 | .6903 | .1306 | .7404 | .3411 | .7975 | .5094 | .8632 | .6573 |
| 9 | .6075 | .9005 | .6467 | .8227 | .6911 | .1347 | .7413 | .3442 | .7986 | .5120 | .8644 | .6597 |
| 10 | 9.6082 | 7.9469 | 9.6474 | 8.8296 | 9.6919 | 9.1387 | 9.7422 | 9.3472 | 9.7996 | 9.5146 | 9.8655 | 9.6621 |
| 11 | .6088 | .9889 | .6481 | .8364 | .6926 | .1428 | .7431 | .3503 | .8006 | .5171 | .8667 | .6644 |
| 12 | .6094 | 8.0273 | .6488 | .8432 | .6934 | .1468 | .7440 | .3533 | .8016 | .5197 | .8679 | .6668 |
| 13 | .6100 | .0627 | .6495 | .8498 | .6942 | .1507 | .7449 | .3563 | .8027 | .5223 | .8691 | .6691 |
| 14 | .6106 | .0955 | .6502 | .8564 | .6950 | .1547 | .7458 | .3593 | .8037 | .5248 | .8703 | .6715 |
| 15 | 9.6112 | 8.1260 | 9.6509 | 8.8628 | 9.6958 | 9.1586 | 9.7467 | 9.3623 | 9.8047 | 9.5274 | 9.8715 | 9.6738 |
| 16 | .6119 | .1547 | .6516 | .8692 | .6966 | .1625 | .7476 | .3653 | .8058 | .5300 | .8727 | .6762 |
| 17 | .6125 | .1816 | .6523 | .8756 | .6974 | .1664 | .7485 | .3683 | .8068 | .5325 | .8739 | .6785 |
| 18 | .6131 | .2071 | .6530 | .8818 | .6982 | .1703 | .7494 | .3713 | .8078 | .5351 | .8751 | .6809 |
| 19 | .6137 | .2312 | .6538 | .8880 | .6990 | .1741 | .7503 | .3742 | .8089 | .5376 | .8763 | .6832 |
| 20 | 9.6144 | 8.2541 | 9.6545 | 8.8941 | 9.6998 | 9.1779 | 9.7512 | 9.3772 | 9.8099 | 9.5401 | 9.8775 | 9.6856 |
| 21 | .6150 | .2759 | .6552 | .9002 | .7006 | .1817 | .7522 | .3801 | .8110 | .5427 | .8787 | .6879 |
| 22 | .6156 | .2967 | .6559 | .9062 | .7014 | .1855 | .7531 | .3831 | .8120 | .5452 | .8799 | .6903 |
| 23 | .6163 | .3166 | .6566 | .9121 | .7022 | .1893 | .7540 | .3860 | .8131 | .5477 | .8812 | .6926 |
| 24 | .6169 | .3357 | .6573 | .9180 | .7030 | .1930 | .7549 | .3889 | .8141 | .5502 | .8824 | .6949 |
| 25 | 9.6175 | 8.3540 | 9.6580 | 8.9238 | 9.7038 | 9.1967 | 9.7558 | 9.3918 | 9.8152 | 9.5528 | 9.8836 | 9.6973 |
| 26 | .6182 | .3717 | .6588 | .9295 | .7047 | .2004 | .7568 | .3947 | .8162 | .5553 | .8848 | .6996 |
| 27 | .6188 | .3887 | .6595 | .9352 | .7055 | .2041 | .7577 | .3976 | .8173 | .5578 | .8861 | .7019 |
| 28 | .6194 | .4051 | .6602 | .9408 | .7063 | .2078 | .7586 | .4005 | .8184 | .5603 | .8873 | .7043 |
| 29 | .6201 | .4210 | .6609 | .9464 | .7071 | .2114 | .7595 | .4033 | .8194 | .5628 | .8885 | .7066 |
| 30 | 9.6207 | 8.4363 | 9.6616 | 8.9519 | 9.7079 | 9.2150 | 9.7605 | 9.4062 | 9.8205 | 9.5653 | 9.8898 | 9.7089 |
| 31 | .6214 | .4512 | .6624 | .9573 | .7088 | .2186 | .7614 | .4090 | .8216 | .5677 | .8910 | .7112 |
| 32 | .6220 | .4657 | .6631 | .9627 | .7096 | .2222 | .7624 | .4119 | .8227 | .5702 | .8923 | .7136 |
| 33 | .6226 | .4796 | .6638 | .9681 | .7104 | .2258 | .7633 | .4147 | .8237 | .5727 | .8935 | .7159 |
| 34 | .6233 | .4932 | .6645 | .9734 | .7112 | .2293 | .7642 | .4175 | .8248 | .5752 | .8948 | .7182 |
| 35 | 9.6239 | 8.5064 | 9.6653 | 8.9787 | 9.7121 | 9.2329 | 9.7652 | 9.4204 | 9.8259 | 9.5777 | 9.8961 | 9.7205 |
| 36 | .6246 | .5192 | .6660 | .9839 | .7129 | .2364 | .7661 | .4232 | .8270 | .5801 | .8973 | .7228 |
| 37 | .6252 | .5318 | .6667 | .9891 | .7137 | .2399 | .7671 | .4260 | .8281 | .5826 | .8986 | .7251 |
| 38 | .6259 | .5440 | .6675 | .9942 | .7146 | .2434 | .7680 | .4288 | .8292 | .5850 | .8999 | .7275 |
| 39 | .6265 | .5559 | .6682 | .9993 | .7154 | .2468 | .7690 | .4316 | .8303 | .5875 | .9011 | .7298 |
| 40 | 9.6272 | 8.5675 | 9.6690 | 9.0043 | 9.7162 | 9.2503 | 9.7699 | 9.4343 | 9.8314 | 9.5900 | 9.9024 | 9.7321 |
| 41 | .6279 | .5788 | .6697 | .0093 | .7171 | .2537 | .7709 | .4371 | .8325 | .5924 | .9037 | .7344 |
| 42 | .6285 | .5899 | .6704 | .0142 | .7179 | .2571 | .7718 | .4399 | .8336 | .5948 | .9050 | .7367 |
| 43 | .6292 | .6008 | .6712 | .0191 | .7187 | .2605 | .7728 | .4426 | .8347 | .5973 | .9063 | .7390 |
| 44 | .6298 | .6114 | .6719 | .0240 | .7196 | .2639 | .7738 | .4454 | .8358 | .5997 | .9075 | .7413 |
| 45 | 9.6305 | 8.6218 | 9.6727 | 9.0288 | 9.7204 | 9.2673 | 9.7747 | 9.4481 | 9.8369 | 9.6022 | 9.9088 | 9.7436 |
| 46 | .6311 | .6320 | .6734 | .0336 | .7213 | .2706 | .7757 | .4509 | .8380 | .6046 | .9101 | .7459 |
| 47 | .6318 | .6419 | .6742 | .0384 | .7221 | .2740 | .7767 | .4536 | .8391 | .6070 | .9114 | .7482 |
| 48 | .6325 | .6517 | .6749 | .0431 | .7230 | .2773 | .7776 | .4563 | .8402 | .6094 | .9127 | .7505 |
| 49 | .6331 | .6613 | .6757 | .0478 | .7238 | .2806 | .7786 | .4590 | .8414 | .6119 | .9140 | .7529 |
| 50 | 9.6338 | 8.6707 | 9.6764 | 9.0524 | 9.7247 | 9.2839 | 9.7796 | 9.4617 | 9.8425 | 9.6143 | 9.9154 | 9.7552 |
| 51 | .6345 | .6799 | .6772 | .0570 | .7256 | .2872 | .7806 | .4644 | .8436 | .6167 | .9167 | .7575 |
| 52 | .6351 | .6890 | .6779 | .0616 | .7264 | .2905 | .7815 | .4671 | .8447 | .6191 | .9180 | .7598 |
| 53 | .6358 | .6979 | .6787 | .0662 | .7273 | .2937 | .7825 | .4698 | .8459 | .6215 | .9193 | .7621 |
| 54 | .6365 | .7067 | .6795 | .0707 | .7281 | .2970 | .7835 | .4725 | .8470 | .6239 | .9206 | .7644 |
| 55 | 9.6372 | 8.7153 | 9.6802 | 9.0752 | 9.7290 | 9.3002 | 9.7845 | 9.4752 | 9.8481 | 9.6263 | 9.9220 | 9.7667 |
| 56 | .6378 | .7237 | .6810 | .0796 | .7299 | .3034 | .7855 | .4778 | .8493 | .6287 | .9233 | .7690 |
| 57 | .6385 | .7321 | .6818 | .0840 | .7307 | .3066 | .7865 | .4805 | .8504 | .6311 | .9246 | .7713 |
| 58 | .6392 | .7402 | .6825 | .0884 | .7316 | .3098 | .7875 | .4831 | .8516 | .6335 | .9260 | .7736 |
| 59 | .6399 | .7483 | .6833 | .0928 | .7324 | .3130 | .7885 | .4858 | .8527 | .6359 | .9273 | .7759 |
| 60 | 9.6406 | 8.7563 | 9.6841 | 9.0971 | 9.7333 | 9.3162 | 9.7895 | 9.4884 | 9.8539 | 9.6383 | 9.9287 | 9.7782 |

# TABLE 37.

### Log. A and Log. B.

[For Computing the Equation of Equal Altitudes. For Noon, A —; for Midnight, A +; for Noon or Midnight, B —.
Argument = Elapsed Time.]

| Elapsed time. | 18ʰ | | 19ʰ | | 20ʰ | | 21ʰ | | 22ʰ | | 23ʰ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. | Log. A. | Log. B. |
| m. | | | | | | | | | | | | |
| 0 | 9. 9287 | 9. 7782 | 0. 0172 | 9. 9167 | 0. 1249 | 0. 0625 | 0. 2623 | 0. 2279 | 0. 4523 | 0. 4372 | 0. 7689 | 0. 7652 |
| 1 | .9300 | .7804 | .0188 | .9190 | .1269 | .0650 | .2649 | .2309 | .4562 | .4414 | .7765 | .7729 |
| 2 | .9314 | .7827 | .0204 | .9213 | .1290 | .0676 | .2676 | .2339 | .4601 | .4455 | .7842 | .7807 |
| 3 | .9327 | .7850 | .0221 | .9237 | .1310 | .0701 | .2702 | .2370 | .4640 | .4497 | .7920 | .7886 |
| 4 | .9341 | .7873 | .0237 | .9260 | .1330 | .0727 | .2729 | .2401 | .4680 | .4540 | .8000 | .7967 |
| 5 | 9. 9355 | 9. 7896 | 0. 0253 | 9. 9284 | 0. 1351 | 0. 0753 | 0. 2756 | 0. 2431 | 0. 4720 | 0. 4582 | 0. 8081 | 0. 8049 |
| 6 | .9368 | .7919 | .0270 | .9307 | .1371 | .0779 | .2783 | .2462 | .4761 | .4625 | .8163 | .8133 |
| 7 | .9382 | .7942 | .0286 | .9331 | .1392 | .0805 | .2810 | .2493 | .4801 | .4668 | .8247 | .8218 |
| 8 | .9396 | .7965 | .0303 | .9355 | .1412 | .0830 | .2838 | .2524 | .4842 | .4711 | .8333· | .8305 |
| 9 | .9410 | .7988 | .0319 | .9378 | .1433 | .0856 | .2865 | .2556 | .4884 | .4755 | .8420 | .8393 |
| 10 | 9. 9424 | 9. 8011 | 0. 0336 | 9. 9402 | 0. 1454 | 0. 0882 | 0. 2893 | 0. 2587 | 0. 4926 | 0. 4799 | 0. 8508 | 0. 8483 |
| 11 | .9437 | .8034 | .0353 | .9426 | .1475 | .0909 | .2921 | .2619 | .4968 | .4844 | .8599 | .8574 |
| 12 | .9451 | .8057 | .0370 | .9449 | .1496 | .0935 | .2949 | .2650 | .5010 | .4889 | .8691 | .8667 |
| 13 | .9465 | .8080 | .0386 | .9473 | .1517 | .0961 | .2977 | .2682 | .5053 | .4934 | .8786 | .8763 |
| 14 | .9479 | .8103 | .0403 | .9497 | .1538 | .0987 | .3005 | .2714 | .5097 | .4980 | .8882 | .8860 |
| 15 | 9. 9493 | 9. 8126 | 0. 0420 | 9. 9520 | 0. 1559 | 0. 1013 | 0. 3034 | 0. 2746 | 0. 5140 | 0. 5026 | 0. 8980 | 0. 8959 |
| 16 | .9508 | .8149 | .0437 | .9544 | .1581 | .1040 | .3063 | .2778 | .5184 | .5072 | .9080 | .9060 |
| 17 | .9522 | .8172 | .0454 | .9568 | .1602 | .1066 | .3091 | .2811 | .5229 | .5118 | .9183 | .9164 |
| 18 | .9536 | .8195 | .0472 | .9592 | .1623 | .1093 | .3120 | .2843 | .5274 | .5165 | .9288 | .9270 |
| 19 | .9550 | .8218 | .0489 | .9616 | .1645 | .1119 | .3150 | .2876 | .5319 | .5213 | .9396 | .9378 |
| 20 | 9. 9564 | 9. 8241 | 0. 0506 | 9. 9640 | 0. 1667 | 0. 1146 | 0. 3179 | 0. 2909 | 0. 5365 | 0. 5261 | 0. 9506 | 0. 9489 |
| 21 | .9579 | .8264 | .0523 | .9664 | .1689 | .1173 | .3208 | .2942 | .5411 | .5309 | .9618 | .9603 |
| 22 | .9593 | .8287 | .0541 | .9687 | .1711 | .1200 | .3238 | .2975 | .5458 | .5358 | .9734 | .9719 |
| 23 | .9607 | .8310 | .0558 | .9711 | .1733 | .1226 | .3268 | .3008 | .5505 | .5407 | .9853 | .9839 |
| 24 | .9622 | .8333 | .0576 | .9735 | .1755 | .1253 | .3298 | .3041 | .5553 | .5457 | .9975 | .9961 |
| 25 | 9. 9636 | 9. 8356 | 0. 0593 | 9. 9760 | 0. 1777 | 0. 1280 | 0. 3328 | 0. 3075 | 0. 5601 | 0. 5507 | 1. 0100 | 1. 0087 |
| 26 | .9651 | .8379 | .0611 | .9784 | .1799 | .1308 | .3359 | .3109 | .5649 | .5557 | .0228 | .0216 |
| 27 | .9665 | .8402 | .0628 | .9808 | .1821 | .1335 | .3389 | .3143 | .5698 | .5608 | .0361 | .0350 |
| 28 | .9680 | .8425 | .0646 | .9832 | .1844 | .1362 | .3420 | .3177 | .5748 | .5660 | .0497 | .0487 |
| 29 | .9695 | .8448 | .0664 | .9856 | .1867 | .1389 | .3451 | .3211 | .5798 | .5712 | .0638 | .0628 |
| 30 | 9. 9709 | 9. 8471 | 0. 0682 | 9. 9880 | 0. 1889 | 0. 1417 | 0. 3482 | 0. 3245 | 0. 5848 | 0. 5764 | 1. 0783 | 1. 0774 |
| 31 | .9724 | .8494 | .0700 | .9904 | .1912 | .1444 | .3514 | .3280 | .5899 | .5817 | .0934 | .0925 |
| 32 | .9739 | .8517 | .0718 | .9929 | .1935 | .1472 | .3545 | .3315 | .5951 | .5871 | .1089 | .1081 |
| 33 | .9754 | .8540 | .0736 | .9953 | .1958 | .1499 | .3577 | .3350 | .6003 | .5925 | .1250 | .1242 |
| 34 | .9769 | .8563 | .0754 | .9977 | .1981 | .1527 | .3609 | .3385 | .6056 | .5979 | .1416 | .1409 |
| 35 | 9. 9784 | 9. 8586 | 0. 0772 | 0. 0002 | 0. 2004 | 0. 1555 | 0. 3641 | 0. 3420 | 0. 6110 | 0. 6034 | 1. 1590 | 1. 1583 |
| 36 | .9798 | .8609 | .0790 | .0026 | .2028 | .1582 | .3674 | .3456 | .6164 | .6090 | .1770 | .1764 |
| 37 | .9813 | .8632 | .0809 | .0051 | .2051 | .1610 | .3706 | .3491 | .6218 | .6147 | .1958 | .1952 |
| 38 | .9829 | .8655 | .0827 | .0075 | .2075 | .1638 | .3739 | .3527 | .6273 | .6204 | .2154 | .2149 |
| 39 | .9844 | .8678 | .0845 | .0100 | .2098 | .1667 | .3772 | .3563 | ˙.6329 | .6261 | .2359 | .2354 |
| 40 | 9. 9859 | 9. 8701 | 0. 0864 | 0. 0124 | 0. 2122 | 0. 1695 | 0. 3805 | 0. 3599 | 0. 6386 | 0. 6319 | 1. 2573 | 1. 2569 |
| 41 | .9874 | .8724 | .0883 | .0149 | .2146 | .1723 | .3839 | .3636 | .6443 | .6378 | .2799 | .2795 |
| 42 | .9889 | .8748 | .0901 | .0173 | .2170 | .1751 | .3873 | .3673 | .6501 | .6438 | .3037 | .3033 |
| 43 | .9904 | .8771 | .0920 | .0198 | .2194 | .1780 | .3907 | .3710 | .6560 | .6498 | .3288 | .3285 |
| 44 | .9920 | .8794 | .0939 | .0223 | .2218 | .1808 | .3941 | .3747 | .6619 | .6559 | .3554 | .3552 |
| 45 | 9. 9935 | 9. 8817 | 0. 0958 | 0. 0248 | 0. 2243 | 0. 1837 | 0. 3975 | 0. 3784 | 0. 6679 | 0. 6621 | 1. 3837 | 1. 3835 |
| 46 | .9951 | .8840 | .0976 | .0272 | .2267 | .1866 | .4010 | .3822 | .6740 | .6684 | .4140 | .4138 |
| 47 | .9966 | .8863 | .0995 | .0297 | .2292 | .1895 | .4045 | .3859 | .6802 | .6747 | .4465 | .4463 |
| 48 | .9982 | .8887 | .1015 | .0322 | .2316 | .1924 | .4080 | ,3897 | .6865 | .6811 | .4815 | .4814 |
| 49 | .9998 | .8910 | .1034 | .0347 | .2341 | .1953 | .4115 | .3936 | .6928 | .6876 | .5196 | .5195 |
| 50 | 0. 0013 | 9. 8933 | 0. 1053 | 0. 0372 | 0. 2366 | 0. 1982 | 0. 4151 | 0. 3974 | 0. 6993 | 0. 6942 | 1. 5613 | 1. 5612 |
| 51 | .0029 | .8956 | .1072 | .0397 | .2391 | .2011 | .4187 | .4013 | .7058 | .7008 | .6074 | .6073 |
| 52 | .0044 | .8980 | .1092 | .0422 | .2416 | .2040 | .4223 | .4052 | .7124 | .7076 | .6588 | .6587 |
| 53 | .0060 | .9003 | .1111 | .0447 | .2442 | .2070 | .4260 | .4091 | .7191 | .7144 | .7171 | .7171 |
| 54 | .0076 | .9026 | .1131 | .0473 | .2467 | .2099 | .4297 | .4130 | .7259 | .7214 | .7844 | .7843 |
| 55 | 0. 0092 | 9. 9050 | 0. 1150 | 0. 0498 | 0. 2493 | 0. 2129 | 0. 4334 | 0. 4170 | 0. 7328 | 0. 7284 | 1. 8638 | 1. 8638 |
| 56 | .0108 | .9073 | .1170 | .0523 | .2518 | .2159 | .4371 | .4210 | .7398 | .7355 | .9610 | .9610 |
| 57 | .0124 | .9096 | .1190 | ˙.0548 | .2544 | .2189 | .4408 | .4250 | .7469 | .7428 | 2. 0863 | 2. 0863 |
| 58 | .0140 | .9120 | .1209 | .0574 | .2570 | .2219 | .4446 | .4291 | .7541 | .7501 | .2627 | .2627 |
| 59 | .0156 | .9143 | .1229 | .0599 | .2596 | .2249 | .4485 | .4331 | .7615 | .7576 | 2. 5640 | 2. 5640 |
| 60 | 0. 0172 | 9. 9167 | 0. 1249 | 0. 0625 | 0. 2623 | 0. 2279 | 0. 4523 | 0. 4372 | 0. 7689 | 0. 7652 | Inf. | Inf. |

TABLE 38. [Page 575

Error in Longitude due to one minute Error of Latitude.

Latitude.

| Sun's altitude | Polar distance | 0° | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 55° | 60° | 65° | 70° | 75° | Polar distance | Sun's altitude |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 110 | .4 | .4 | .4 | .5 | .5 | .6 | .7 | .8 | 1.0 | 1.3 | 1.8 | 2.9 | | | | | 110 | 10 |
| 20 | | .4 | .4 | .5 | .6 | .7 | .8 | 1.0 | 1.2 | 1.6 | 2.6 | | | | | | | | 20 |
| 30 | | .4 | .5 | .6 | .7 | .9 | 1.1 | 1.5 | 2.3 | | | | | | | | | | 30 |
| 40 | | .5 | .6 | .8 | 1.0 | 1.3 | | | | | | | | | | | | | 40 |
| 50 | | .7 | .9 | 1.2 | | | | | | | | | | | | | | | 50 |
| 60 | | .9 | | | | | | | | | | | | | | | | | 60 |
| 10 | 105 | .3 | .3 | .3 | .3 | .4 | .4 | .5 | .6 | .8 | .9 | 1.2 | 1.8 | 3.0 | | | | 105 | 10 |
| 20 | | .3 | .3 | .4 | .4 | .5 | .6 | .7 | .9 | 1.2 | 1.6 | 2.7 | | | | | | | 20 |
| 30 | | .3 | .4 | .5 | .6 | .7 | .8 | 1.1 | 1.5 | 2.4 | | | | | | | | | 30 |
| 40 | | .4 | .5 | .6 | .7 | 1.0 | 1.3 | | | | | | | | | | | | 40 |
| 50 | | .4 | .6 | .8 | 1.2 | | | | | | | | | | | | | | 50 |
| 60 | | .6 | .9 | | | | | | | | | | | | | | | | 60 |
| 15 | 100 | .2 | .2 | .2 | .3 | .3 | .4 | .4 | .5 | .6 | .8 | 1.1 | 1.6 | 2.9 | | | | 100 | 15 |
| 20 | | .2 | .2 | .3 | .3 | .4 | .5 | .5 | .7 | .9 | 1.1 | 1.6 | 2.7 | | | | | | 20 |
| 30 | | .2 | .3 | .3 | .4 | .5 | .6 | .8 | 1.1 | 1.5 | 2.4 | | | | | | | | 30 |
| 40 | | .2 | .3 | .4 | .6 | .7 | .9 | 1.3 | 2.1 | | | | | | | | | | 40 |
| 50 | | .3 | .4 | .6 | .8 | 1.2 | | | | | | | | | | | | | 50 |
| 60 | | .3 | .6 | .9 | | | | | | | | | | | | | | | 60 |
| 15 | 95 | .1 | .1 | .1 | .2 | .2 | .3 | .3 | .4 | .5 | .6 | .8 | 1.1 | 1.7 | 3.0 | | | 95 | 15 |
| 20 | | .1 | .1 | .2 | .2 | .3 | .3 | .4 | .5 | .6 | .8 | 1.1 | 1.6 | 2.8 | | | | | 20 |
| 30 | | .1 | .2 | .2 | .3 | .4 | .5 | .6 | .8 | 1.0 | 1.5 | 2.5 | | | | | | | 30 |
| 40 | | .1 | .2 | .3 | .4 | .5 | .7 | .9 | 1.3 | 2.1 | | | | | | | | | 40 |
| 50 | | .1 | .3 | .4 | .6 | .8 | 1.1 | | | | | | | | | | | | 50 |
| 60 | | .2 | .3 | .6 | .9 | | | | | | | | | | | | | | 60 |
| 20 | 90 | .0 | .0 | .1 | .1 | .1 | .2 | .2 | .3 | .4 | .6 | .7 | 1.1 | 1.6 | 3.0 | | | 90 | 20 |
| 30 | | .0 | .1 | .1 | .2 | .2 | .3 | .4 | .5 | .7 | 1.0 | 1.5 | 2.7 | | | | | | 30 |
| 40 | | .0 | .1 | .2 | .3 | .3 | .5 | .6 | .9 | 1.3 | 2.2 | | | | | | | | 40 |
| 50 | | .0 | .1 | .2 | .4 | .5 | .8 | 1.1 | | | | | | | | | | | 50 |
| 60 | | .0 | .2 | .3 | .5 | .9 | | | | | | | | | | | | | 60 |
| 70 | | .0 | .2 | .6 | 1.1 | | | | | | | | | | | | | | 70 |
| 20 | 85 | .1* | .1* | .0 | .0 | .0 | .1 | .1 | .2 | .3 | .3 | .5 | .7 | 1.0 | 1.6 | 3.1 | | 85 | 20 |
| 30 | | .1* | .0 | .0 | .1 | .1 | .2 | .2 | .4 | .5 | .7 | 1.0 | 1.5 | 2.7 | | | | | 30 |
| 40 | | .1* | .0 | .0 | .1 | .2 | .3 | .4 | .6 | .9 | 1.3 | 2.3 | | | | | | | 40 |
| 50 | | .1* | .0 | .1 | .2 | .3 | .5 | .7 | 1.1 | | | | | | | | | | 50 |
| 60 | | .2* | .0 | .1 | .3 | .5 | .9 | | | | | | | | | | | | 60 |
| 70 | | .3* | .0 | .2 | .6 | 1.1 | | | | | | | | | | | | | 70 |
| 20 | 80 | .2* | .2* | .1* | .1* | .1* | .0 | .0 | .0 | .1 | .1 | .2 | .4 | .5 | .9 | 1.5 | 3.1 | 80 | 20 |
| 30 | | .2* | .2* | .1* | .0 | .0 | .1 | .1 | .2 | .3 | .4 | .6 | .9 | 1.5 | 2.8 | | | | 30 |
| 40 | | .2* | .2* | .1* | .0 | .1 | .2 | .3 | .4 | .6 | .9 | 1.3 | 2.4 | | | | | | 40 |
| 50 | | .3* | .2* | .1* | .1 | .2 | .3 | .5 | .7 | 1.1 | | | | | | | | | 50 |
| 60 | | .4* | .2* | .0 | .1 | .3 | .5 | .9 | | | | | | | | | | | 60 |
| 70 | | .6* | .3* | .0 | .2 | .6 | 1.2 | | | | | | | | | | | | 70 |
| 20 | 75 | .3* | .3* | .2* | .2* | .2* | .1* | .1* | .1* | .1* | .0 | .0 | .1 | .2 | .3 | .6 | 1.2 | 75 | 20 |
| 30 | | .3* | .3* | .2* | .2* | .1* | .1* | .0 | .1 | .1 | .2 | .4 | .6 | .9 | 1.5 | 3.0 | | | 30 |
| 40 | | .4* | .3* | .2* | .1* | .1* | .0 | .1 | .2 | .4 | .5 | .8 | 1.3 | 2.5 | | | | | 40 |
| 50 | | .4* | .3* | .2* | .1* | .0 | .1 | .3 | .5 | .7 | 1.1 | | | | | | | | 50 |
| 60 | | .6* | .4* | .2* | .1* | .1 | .3 | .5 | .9 | | | | | | | | | | 60 |
| 70 | | 1.2* | .6* | .3* | .0 | .2 | .6 | 1.2 | | | | | | | | | | | 70 |
| 20 | 70 | .4* | .4* | .3* | .3* | .3* | .3* | .2* | .2* | .2* | .2* | .2* | .2* | .2* | .2* | .2* | .2* | 70 | 20 |
| 30 | | .4* | .4* | .3* | .3* | .2* | .2* | .1* | .1* | .0 | .0 | .1 | .2 | .6 | .8 | 1.5 | 3.1 | | 30 |
| 40 | | .5* | .4* | .3* | .3* | .2* | .1* | .0 | .1 | .3 | .8 | 1.3 | 2.6 | | | | | | 40 |
| 50 | | .6* | .5* | .3* | .2* | .2* | .0 | .1 | .3 | .4 | .7 | 1.1 | | | | | | | 50 |
| 60 | | .9* | .6* | .4* | .3* | .1* | .1 | .2 | .5 | .9 | | | | | | | | | 60 |
| 70 | | 1.2* | .6* | .3* | .1* | .2 | .6 | 1.2 | | | | | | | | | | | 70 |

Latitude.

# TABLE 39.

## Amplitudes.

| Lati-tude. | Declination. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0°.0 | 0°.5 | 1°.0 | 1°.5 | 2°.0 | 2°.5 | 3°.0 | 3°.5 | 4°.0 | 4°.5 | 5°.0 | 5°.5 | 6°.0 | |
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0 | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 0 |
| 10 | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.1 | 4.6 | 5.1 | 5.6 | 6.1 | 10 |
| 15 | 0.0 | 0.5 | 1.0 | 1.5 | 2.1 | 2.6 | 3.1 | 3.6 | 4.2 | 4.7 | 5.2 | 5.7 | 6.2 | 15 |
| 20 | 0.0 | 0.5 | 1.1 | 1.6 | 2.1 | 2.7 | 3.2 | 3.7 | 4.3 | 4.8 | 5.3 | 5.8 | 6.4 | 20 |
| 25 | 0.0 | 0.5 | 1.1 | 1.6 | 2.2 | 2.8 | 3.3 | 3.8 | 4.4 | 5.0 | 5.5 | 6.0 | 6.6 | 25 |
| 30 | 0.0 | 0.6 | 1.2 | 1.7 | 2.3 | 2.9 | 3.4 | 4.0 | 4.6 | 5.2 | 5.8 | 6.3 | 6.9 | 30 |
| 32 | 0.0 | 0.6 | 1.2 | 1.8 | 2.4 | 2.9 | 3.5 | 4.1 | 4.7 | 5.3 | 5.9 | 6.5 | 7.0 | 32 |
| 34 | 0.0 | 0.6 | 1.2 | 1.8 | 2.4 | 3.0 | 3.6 | 4.2 | 4.8 | 5.4 | 6.0 | 6.6 | 7.2 | 34 |
| 36 | 0.0 | 0.6 | 1.2 | 1.8 | 2.5 | 3.1 | 3.7 | 4.3 | 4.9 | 5.6 | 6.1 | 6.8 | 7.4 | 36 |
| 38 | 0.0 | 0.6 | 1.3 | 1.9 | 2.5 | 3.2 | 3.8 | 4.4 | 5.1 | 5.7 | 6.3 | 7.0 | 7.6 | 38 |
| 40 | 0.0 | 0.7 | 1.3 | 2.0 | 2.6 | 3.3 | 3.9 | 4.6 | 5.2 | 5.9 | 6.5 | 7.2 | 7.8 | 40 |
| 42 | 0.0 | 0.7 | 1.3 | 2.0 | 2.7 | 3.4 | 4.0 | 4.7- | 5.4 | 6.1 | 6.7 | 7.4 | 8.0 | 42 |
| 44 | 0.0 | 0.7 | 1.4 | 2.1 | 2.8 | 3.5 | 4.2 | 4.9 | 5.6 | 6.3 | 6.9 | 7.6 | 8.3 | 44 |
| 46 | 0.0 | 0.7 | 1.4 | 2.2 | 2.9 | 3.6 | 4.3 | 5.0 | 5.8 | 6.5 | 7.2 | 7.9 | 8.6 | 46 |
| 48 | 0.0 | 0.7 | 1.5 | 2.2 | 3.0 | 3.7 | 4.5 | 5.2 | 6.0 | 6.7 | 7.5 | 8.2 | 9.0 | 48 |
| 50 | 0.0 | 0.8 | 1.5 | 2.3 | 3.1 | 3.9 | 4.7 | 5.4 | 6.2 | 7.0 | 7.8 | 8.6 | 9.3 | 50 |
| 51 | 0.0 | 0.8 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 5.6 | 6.4 | 7.2 | 8.0 | 8.8 | 9.5 | 51 |
| 52 | 0.0 | 0.8 | 1.6 | 2.4 | 3.3 | 4.1 | 4.9 | 5.7 | 6.5 | 7.3 | 8.1 | 9.0 | 9.7 | 52 |
| 53 | 0.0 | 0.8 | 1.6 | 2.5 | 3.3 | 4.2 | 5.0 | 5.8 | 6.7 | 7.5 | 8.3 | 9.2 | 10.0 | 53 |
| 54 | 0.0 | 0.9 | 1.7 | 2.5 | 3.4 | 4.3 | 5.1 | 6.0 | 6.8 | 7.7 | 8.5 | 9.4 | 0.2 | 54 |
| 55 | 0.0 | 0.9 | 1.7 | 2.6 | 3.5 | 4.4 | 5.2 | 6.1 | 7.0 | 7.9 | 8.7 | 9.6 | 10.5 | 55 |
| 56 | 0.0 | 0.9 | 1.8 | 2.7 | 3.6 | 4.5 | 5.4 | 6.3 | 7.2 | 8.1 | 9.0 | 9.9 | 0.8 | 56 |
| 57 | 0.0 | 0.9 | 1.8 | 2.7 | 3.7 | 4.6 | 5.5 | 6.4 | 7.4 | 8.3 | 9.2 | 10.1 | 1.1 | 57 |
| 58 | 0.0 | 0.9 | 1.9 | 2.8 | 3.8 | 4.7 | 5.7 | 6.6 | 7.6 | 8.5 | 9.5 | 0.4 | 1.4 | 58 |
| 59 | 0.0 | 1.0 | 1.9 | 2.9 | 3.9 | 4.9 | 5.8 | 6.8 | 7.8 | 8.8 | 9.7 | 0.7 | 1.7 | 59 |
| 60 | 0.0. | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.1 | 60 |
| 61 | 0.0 | 1.0 | 2.1 | 3.1 | 4.1 | 5.2 | 6.2 | 7.2 | 8.3 | 9.3 | 0.3 | 1.4 | 2.5 | 61 |
| 62 | 0.0 | 1.1 | 2.1 | 3.2 | 4.3 | 5.3 | 6.4 | 7.5 | 8.5 | 9.6 | 0.7 | 1.8 | 2.9 | 62 |
| 63 | 0.0 | 1.1 | 2.2 | 3.3 | 4.5 | 5.5 | 6.6 | 7.7 | 8.8 | 9.9 | 1.1 | 2.2 | 3.4 | 63 |
| 64 | 0.0 | 1.1 | 2.3 | 3.4 | 4.6 | 5.7 | 6.9 | 8.0 | 9.2 | 10.3 | 1.5 | 2.6 | 3.9 | 64 |
| 65.0 | 0.0 | 1.2 | 2.4 | 3.5 | 4.8 | 5.9 | 7.1 | 8.3 | 9.5 | 10.7 | 11.9 | 13.1 | 14.4 | 65.0 |
| 5.5 | 0.0 | 1.2 | 2.4 | 3.6 | 4.8 | 6.0 | 7.2 | 8.5 | 9.7 | 0.9 | 2.1 | 3.4 | 4.6 | 5.5 |
| 6.0 | 0.0 | 1.2 | 2.5 | 3.7 | 4.9 | 6.1 | 7.4 | 8.6 | 9.9 | 1.1 | 2.4 | 3.6 | 4.9 | 6.0 |
| 6.5 | 0.0 | 1.2 | 2.5 | 3.8 | 5.0 | 6.3 | 7.5 | 8.8 | 10.1 | 1.3 | 2.6 | 3.9 | 5.2 | 6.5 |
| 7.0 | 0.0 | 1.3 | 2.6 | 3.8 | 5.1 | 6.4 | 7.7 | 9.0 | 0.3 | 1.6 | 2.9 | 4.2 | 5.5 | 7.0 |
| 67.5 | 0.0 | 1.3 | 2.6 | 3.9 | 5.2 | 6.5 | 7.9 | 9.2 | 10.5 | 11.8 | 13.2 | 14.5 | 15.9 | 67.5 |
| 8.0 | 0.0 | 1.3 | 2.7 | 4.0 | 5.3 | 6.7 | 8.0 | 9.4 | 0.7 | 2.1 | 3.5 | 4.8 | 6.2 | 8.0 |
| 8.5 | 0.0 | 1.4 | 2.7 | 4.1 | 5.4 | 6.8 | 8.2 | 9.6 | 1.0 | 2.4 | 3.8 | 5.2 | 6.6 | 8.5 |
| 9.0 | 0.0 | 1.4 | 2.8 | 4.2 | 5.5 | 7.0 | 8.4 | 9.8 | 1.2 | 2.6 | 4.1 | 5.5 | 7.0 | 9.0 |
| 9.5 | 0.0 | 1.4 | 2.9 | 4.3 | 5.7 | 7.2 | 8.6 | 10.0 | 1.5 | 2.9 | 4.4 | 5.9 | 7.4 | 9.5 |
| 70.0 | 0.0 | 1.5 | 2.9 | 4.4 | 5.8 | 7.3 | 8.8 | 10.3 | 11.8 | 13.3 | 14.8 | 16.3 | 17.8 | 70.0 |
| 0.5 | 0.0 | 1.5 | 3.0 | 4.5 | 6.0 | 7.5 | 9.0 | 0.5 | 2.1 | 3.6 | 5.1 | 6.7 | 8.2 | 0.5 |
| 1.0 | 0.0 | 1.5 | 3.1 | 4.6 | 6.2 | 7.7 | 9.3 | 0.8 | 2.4 | 3.9 | 5.5 | 7.1 | 8.7 | 1.0 |
| 1.5 | 0.0 | 1.6 | 3.2 | 4.7 | 6.3 | 7.9 | 9.5 | 1.1 | 2.7 | 4.3 | 5.9 | 7.8 | 9.2 | 1.5 |
| 2.0 | 0.0 | 1.6 | 3.2 | 4.9 | 6.5 | 8.1 | 9.8 | 1.4 | 3.0 | 4.7 | 6.4 | 8.1 | 9.8 | 2.0 |
| 72.5 | 0.0 | 1.7 | 3.3 | 5.0 | 6.7 | 8.3 | 10.0 | 11.7 | 13.4 | 15.1 | 16.9 | 18.6 | 20.3 | 72.5 |
| 3.0 | 0.0 | 1.7 | 3.4 | 5.1 | 6.9 | 8.6 | 0.3 | 2.0 | 3.8 | 5.5 | 7.4 | 9.1 | 0.9 | 3.0 |
| 3.5 | 0.0 | 1.8 | 3.5 | 5.2 | 7.1 | 8.8 | 0.6 | 2.4 | 4.2 | 6.0 | 7.9 | 9.7 | 1.6 | 3.5 |
| 4.0 | 0.0 | 1.8 | 3.6 | 5.4 | 7.3 | 9.1 | 0.9 | 2.8 | 4.6 | 6.5 | 8.4 | 20.3 | 2.3 | 4.0 |
| 4.5 | 0.0 | 1.9 | 3.7 | 5.6 | 7.5 | 9.4 | 1.3 | 3.2 | 5.1 | 7.1 | 9.0 | 1.0 | 3.0 | 4.5 |
| 75.0 | 0.0 | 1.9 | 3.8 | 5.8 | 7.7 | 9.7 | 11.7 | 13.6 | 15.6 | 17.7 | 19.7 | 21.7 | 23.8 | 75.0 |
| 5.5 | 0.0 | 2.0 | 3.9 | 6.0 | 8.0 | 10.0 | 2.1 | 4.1 | 6.2 | 8.3 | 20.4 | 2.5 | 4.7 | 5.5 |
| 6.0 | 0.0 | 2.1 | 4.0 | 6.2 | 8.3 | 0.4 | 2.5 | 4.6 | 6.8 | 8.9 | 1.1 | 3.3 | 5.6 | 6.0 |
| 6.5 | 0.0 | 2.1 | 4.2 | 6.4 | 8.6 | 0.8 | 3.0 | 5.2 | 7.4 | 9.6 | 1.9 | 4.2 | 6.6 | 6.5 |
| 7.0 | 0.0 | 2.2 | 4.4 | 6.6 | 8.9 | 1.2 | 3.5 | 5.8 | 8.1 | 20.4 | 2.8 | 5.2 | 7.7 | 7.0 |

# TABLE 39.

[Page 577

## Amplitudes.

| Lati-tude. | Declination. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6°.0 | 6°.5 | 7°.0 | 7°.5 | 8°.0 | 8°.5 | 9°.0 | 9°.5 | 10°.0 | 10°.5 | 11°.0 | 11°.5 | 12°.0 | |
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 | 10.5 | 11.0 | 11.5 | 12.0 | 0 |
| 10 | 6.1 | 6.6 | 7.1 | 7.6 | 8.1 | 8.6 | 9.1 | 9.7 | 0.1 | 0.7 | 1.2 | 1.7 | 2.2 | 10 |
| 15 | 6.2 | 6.7 | 7.2 | 7.8 | 8.3 | 8.8 | 9.3 | 9.8 | 0.4 | 0.9 | 1.4 | 1.9 | 2.5 | 15 |
| 20 | 6.4 | 6.9 | 7.4 | 8.0 | 8.5 | 9.1 | 9.6 | 10.1 | 0.7 | 1.2 | 1.7 | 2.3 | 2.8 | 20 |
| 25 | 6.6 | 7.1 | 7.7 | 8.3 | 8.8 | 9.4 | 9.9 | 0.5 | 1.1 | 1.6 | 2.2 | 2.8 | 3.3 | 25 |
| 30 | 6.9 | 7.5 | 8.1 | 8.7 | 9.3 | 9.8 | 10.4 | 11.0 | 11.5 | 12.1 | 12.7 | 13.3 | 13.9 | 30 |
| 32 | 7.0 | 7.7 | 8.3 | 8.8 | 9.5 | 10.0 | 0.6 | 1.2 | 1.8 | 2.4 | 3.0 | 3.6 | 4.2 | 32 |
| 34 | 7.2 | 7.8 | 8.5 | 9.0 | 9.7 | 0.3 | 0.8 | 1.5 | 2.1 | 2.7 | 3.3 | 3.9 | 4.5 | 34 |
| 36 | 7.4 | 8.0 | 8.7 | 9.3 | 9.9 | 0.5 | 1.1 | 1.8 | 2.4 | 3.0 | 3.6 | 4.3 | 4.9 | 36 |
| 38 | 7.6 | 8.2 | 8.9 | 9.5 | 10.2 | 0.8 | 1.4 | 2.1 | 2.7 | 3.4 | 4.0 | 4.7 | 5.3 | 38 |
| 40 | 7.8 | 8.5 | 9.1 | 9.8 | 10.5 | 11.1 | 11.7 | 12.4 | 13.1 | 13.8 | 14.4 | 15.1 | 15.7 | 40 |
| 42 | 8.0 | 8.8 | 9.4 | 10.1 | 0.8 | 1.5 | 2.1 | 2.8 | 3.5 | 4.2 | 4.8 | 5.6 | 6.2 | 42 |
| 44 | 8.3 | 9.1 | 9.7 | 0.5 | 1.1 | 1.9 | 2.5 | 3.3 | 4.0 | 4.7 | 5.3 | 6.1 | 6.8 | 44 |
| 46 | 8.6 | 9.4 | 10.1 | 0.8 | 1.5 | 2.3 | 3.0 | 3.8 | 4.5 | 5.2 | 5.9 | 6.7 | 7.4 | 46 |
| 48 | 9.0 | 9.7 | 0.5 | 1.2 | 2.0 | 2.8 | 3.5 | 4.3 | 5.0 | 5.8 | 6.6 | 7.3 | 8.1 | 48 |
| 50 | 9.3 | 10.1 | 10.9 | 11.7 | 12.5 | 13.3 | 14.1 | 14.9 | 15.7 | 16.5 | 17.3 | 18.1 | 18.9 | 50 |
| 51 | 9.5 | 0.4 | 1.2 | 2.0 | 2.8 | 3.6 | 4.4 | 5.2 | 6.0 | 6.8 | 7.7 | 8.5 | 9.3 | 51 |
| 52 | 9.7 | 0.6 | 1.4 | 2.2 | 3.1 | 3.9 | 4.7 | 5.6 | 6.4 | 7.2 | 8.1 | 8.9 | 9.7 | 52 |
| 53 | 10.0 | 0.8 | 1.7 | 2.5 | 3.4 | 4.2 | 5.1 | 5.9 | 6.8 | 7.6 | 8.5 | 9.4 | 20.2 | 53 |
| 54 | 0.2 | 1.1 | 2.0 | 2.8 | 3.7 | 4.6 | 5.4 | 6.3 | 7.2 | 8.1 | 8.9 | 9.8 | 0.7 | 54 |
| 55 | 10.5 | 11.4 | 12.3 | 13.1 | 14.0 | 14.9 | 15.8 | 16.7 | 17.6 | 18.5 | 19.4 | 20.3 | 21.2 | 55 |
| 56 | 0.8 | 1.7 | 2.6 | 3.5 | 4.4 | 5.3 | 6.2 | 7.2 | 8.1 | 9.0 | 9.9 | 0.9 | 1.8 | 56 |
| 57 | 1.1 | 2.0 | 2.9 | 3.9 | 4.8 | 5.8 | 6.7 | 7.7 | 8.6 | 9.6 | 20.5 | 1.5 | 2.4 | 57 |
| 58 | 1.4 | 2.3 | 3.3 | 4.3 | 5.2 | 6.2 | 7.2 | 8.2 | 9.1 | 20.1 | 1.1 | 2.1 | 3.1 | 58 |
| 59 | 1.7 | 2.7 | 3.7 | 4.7 | 5.7 | 6.7 | 7.7 | 8.7 | 9.7 | 0.7 | 1.7 | 2.8 | 3.8 | 59 |
| 60 | 12.1 | 13.1 | 14.1 | 15.1 | 16.2 | 17.2 | 18.2 | 19.3 | 20.3 | 21.4 | 22.4 | 23.5 | 24.6 | 60 |
| 61 | 2.5 | 3.5 | 4.6 | 5.6 | 6.7 | 7.8 | 8.8 | 9.9 | 1.0 | 2.1 | 3.1 | 4.3 | 5.4 | 61 |
| 62 | 2.9 | 3.9 | 5.1 | 6.1 | 7.3 | 8.4 | 9.4 | 20.6 | 1.7 | 2.9 | 3.9 | 5.2 | 6.3 | 62 |
| 63 | 3.4 | 4.4 | 5.6 | 6.7 | 7.9 | 9.0 | 20.1 | 1.3 | 2.5 | 3.7 | 4.8 | 6.1 | 7.2 | 63 |
| 64 | 3.9 | 5.0 | 6.2 | 7.3 | 8.5 | 9.7 | 0.9 | 2.1 | 3.3 | 4.6 | 5.7 | 7.1 | 8.3 | 64 |
| 65.0 | 14.4 | 15.5 | 16.8 | 18.0 | 19.3 | 20.5 | 21.7 | 23.0 | 24.2 | 25.6 | 26.8 | 28.2 | 29.5 | 65.0 |
| 5.5 | 4.6 | 5.8 | 7.1 | 8.3 | 9.6 | 0.9 | 2.2 | 3.5 | 4.7 | 6.1 | 7.4 | 8.7 | 30.1 | 5.5 |
| 6.0 | 4.9 | 6.2 | 7.4 | 8.7 | 20.0 | 1.3 | 2.6 | 3.9 | 5.3 | 6.6 | 8.0 | 9.3 | 0.7 | 6.0 |
| 6.5 | 5.2 | 6.5 | 7.8 | 9.1 | 0.4 | 1.8 | 3.1 | 4.4 | 5.8 | 7.2 | 8.6 | 30.0 | 1.4 | 6.5 |
| 7.0 | 5.5 | 6.8 | 8.2 | 9.5 | 0.9 | 2.2 | 3.6 | 5.0 | 6.4 | 7.8 | 9.2 | 0.7 | 2.1 | 7.0 |
| 67.5 | 15.9 | 17.2 | 18.6 | 19.9 | 21.3 | 22.7 | 24.1 | 25.5 | 27.0 | 28.4 | 29.9 | 31.4 | 32.9 | 67.5 |
| 8.0 | 6.2 | 7.6 | 9.0 | 20.4 | 1.8 | 3.2 | 4.7 | 6.1 | 7.6 | 9.1 | 30.6 | 2.2 | 3.7 | 8.0 |
| 8.5 | 6.6 | 8.0 | 9.4 | 0.9 | 2.3 | 3.8 | 5.3 | 6.8 | 8.3 | 9.8 | 1.4 | 3.0 | 4.6 | 8.5 |
| 9.0 | 7.0 | 8.4 | 9.9 | 1.4 | 2.8 | 4.4 | 5.9 | 7.4 | 9.0 | 30.6 | 2.2 | 3.8 | 5.5 | 9.0 |
| 9.5 | 7.4 | 8.9 | 20.4 | 1.9 | 3.4 | 5.0 | 6.5 | 8.1 | 9.7 | 1.4 | 3.0 | 4.7 | 6.4 | 9.5 |
| 70.0 | 17.8 | 19.3 | 20.9 | 22.4 | 24.0 | 25.6 | 27.2 | 28.8 | 30.5 | 32.2 | 33.9 | 35.7 | 37.4 | 70.0 |
| 0.5 | 8.2 | 9.8 | 1.4 | 3.0 | 4.6 | 6.3 | 7.9 | 9.6 | 1.3 | 3.1 | 4.9 | 6.7 | 8.5 | 0.5 |
| 1.0 | 8.7 | 20.3 | 2.0 | 3.6 | 5.3 | 7.0 | 8.7 | 30.5 | 2.2 | 4.0 | 5.9 | 7.8 | 9.7 | 1.0 |
| 1.5 | 9.2 | 0.9 | 2.6 | 4.3 | 6.0 | 7.8 | 9.5 | 1.4 | 3.2 | 5.0 | 7.0 | 8.9 | 40.9 | 1.5 |
| 2.0 | 9.8 | 1.5 | 3.2 | 5.0 | 6.8 | 8.6 | 30.4 | 2.3 | 4.2 | 6.1 | 8.1 | 40.2 | 2.3 | 2.0 |
| 72.5 | 20.3 | 22.1 | 23.9 | 25.7 | 27.6 | 29.5 | 31.4 | 33.3 | 35.3 | 37.3 | 39.4 | 41.5 | 43.7 | 72.5 |
| 3.0 | 0.9 | 2.8 | 4.6 | 6.5 | 8.4 | 30.4 | 2.4 | 4.4 | 6.5 | 8.6 | 40.8 | 3.0 | 5.3 | 3.0 |
| 3.5 | 1.6 | 3.5 | 5.4 | 7.4 | 9.3 | 1.4 | 3.4 | 5.5 | 7.7 | 9.9 | 2.2 | 4.6 | 7.0 | 3.5 |
| 4.0 | 2.3 | 4.3 | 6.2 | 8.3 | 30.3 | 2.5 | 4.6 | 6.8 | 9.1 | 41.4 | 3.8 | 6.3 | 8.9 | 4.0 |
| 4.5 | 3.0 | 5.1 | 7.1 | 9.3 | 1.4 | 3.6 | 5.8 | 8.2 | 40.5 | 3.0 | 5.6 | 8.2 | 51.1 | 4.5 |
| 75.0 | 23.8 | 26.0 | 28.1 | 30.3 | 32.5 | 34.8 | 37.2 | 39.6 | 42.1 | 44.8 | 47.5 | 50.4 | 53.5 | 75.0 |
| 5.5 | 4.7 | 6.9 | 9.1 | 1.4 | 3.8 | 6.2 | 8.7 | 41.2 | 3.9 | 6.7 | 9.6 | 2.8 | 6.2 | 5.5 |
| 6.0 | 5.6 | 7.9 | 30.2 | 2.6 | 5.1 | 7.7 | 40.3 | 3.0 | 5.9 | 8.9 | 52.1 | 5.5 | 9.3 | 6.0 |
| 6.5 | 6.6 | 9.0 | 1.4 | 4.0 | 6.6 | 9.3 | 2.1 | 5.0 | 8.1 | 51.3 | 4.8 | 8.7 | 63.0 | 6.5 |
| 7.0 | 7.7 | 30.2 | 2.8 | 5.5 | 8.2 | 41.1 | 4.1 | 7.2 | 50.5 | 4.1 | 8.0 | 62.4 | 7.6 | 7.0 |

# TABLE 39.

## Amplitudes.

| Lati-tude. | Declination. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12°.0 | 12°.5 | 13°.0 | 13°.5 | 14°.0 | 14°.5 | 15°.0 | 15°.5 | 16°.0 | 16°.5 | 17°.0 | 17°.5 | 18°.0 | |
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0 | 12.0 | 12.5 | 13.0 | 13.5 | 14.0 | 14.5 | 15.0 | 15.5 | 16.0 | 16.5 | 17.0 | 17.5 | 18.0 | 0 |
| 10 | 2.2 | 2.7 | 3.2 | 3.7 | 4.2 | 4.7 | 5.3 | 5.8 | 6.3 | 6.8 | 7.3 | 7.9 | 8.3 | 10 |
| 15 | 2.5 | 2.9 | 3.5 | 4.0 | 4.5 | 5.0 | 5.6 | 6.1 | 6.6 | 7.1 | 7.7 | 8.2 | 8.7 | 15 |
| 20 | 2.8 | 3.3 | 3.8 | 4.4 | 4.9 | 5.5 | 6.0 | 6.5 | 7.1 | 7.6 | 8.1 | 8.7 | 9.2 | 20 |
| 25 | 3.3 | 3.8 | 4.4 | 4.9 | 5.5 | 6.1 | 6.6 | 7.1 | 7.7 | 8.3 | 8.8 | 9.4 | 9.9 | 25 |
| 30 | 13.9 | 14.5 | 15.0 | 15.6 | 16.2 | 16.8 | 17.4 | 18.0 | 18.6 | 19.2 | 19.7 | 20.3 | 20.9 | 30 |
| 32 | 4.2 | 4.8 | 5.3 | 6.0 | 6.6 | 7.2 | 7.8 | 8.4 | 9.0 | 9.6 | 20.2 | 0.8 | 1.4 | 32 |
| 34 | 4.5 | 5.1 | 5.7 | 6.4 | 7.0 | 7.6 | 8.2 | 8.8 | 9.5 | 20.0 | 0.7 | 1.3 | 1.9 | 34 |
| 36 | 4.9 | 5.5 | 6.1 | 6.8 | 7.4 | 8.0 | 8.7 | 9.3 | 20.0 | 0.5 | 1.2 | 1.8 | 2.5 | 36 |
| 38 | 5.3 | 6.0 | 6.6 | 7.2 | 7.9 | 8.5 | 9.2 | 9.8 | 0.5 | 1.1 | 1.8 | 2.4 | 3.1 | 38 |
| 40 | 15.7 | 16.4 | 17.1 | 17.8 | 18.4 | 19.1 | 19.7 | 20.4 | 21.1 | 21.8 | 22.4 | 23.1 | 23.8 | 40 |
| 41 | 6.0 | 6.7 | 7.3 | 8.0 | 8.7 | 9.4 | 20.0 | 0.8 | 1.4 | 2.1 | 2.8 | 3.5 | 4.2 | 41 |
| 42 | 6.2 | 6.9 | 7.6 | 8.3 | 9.0 | 9.7 | 0.4 | 1.1 | 1.8 | 2.5 | 3.2 | 3.9 | 4.6 | 42 |
| 43 | 6.5 | 7.2 | 7.9 | 8.6 | 9.3 | 20.0 | 0.7 | 1.4 | 2.2 | 2.9 | 3.6 | 4.3 | 5.0 | 43 |
| 44 | 6.8 | 7.5 | 8.2 | 8.9 | 9.6 | 0.4 | 1.1 | 1.8 | 2.6 | 3.3 | 4.0 | 4.7 | 5.4 | 44 |
| 45 | 17.1 | 17.8 | 18.5 | 19.3 | 20.0 | 20.7 | 21.5 | 22.2 | 23.0 | 23.7 | 24.4 | 25.2 | 25.9 | 45 |
| 46 | 7.4 | 8.2 | 8.9 | 9.6 | 0.4 | 1.1 | 1.9 | 2.6 | 3.4 | 4.1 | 4.9 | 5.7 | 6.4 | 46 |
| 47 | 7.7 | 8.5 | 9.3 | 20.0 | 0.8 | 1.5 | 2.3 | 3.1 | 3.8 | 4.6 | 5.4 | 6.2 | 6.9 | 47 |
| 48 | 8.1 | 8.9 | 9.7 | 0.4 | 1.2 | 2.0 | 2.8 | 3.6 | 4.3 | 5.1 | 5.9 | 6.7 | 7.5 | 48 |
| 49 | 8.5 | 9.3 | 20.1 | 0.8 | 1.6 | 2.4 | 3.2 | 4.1 | 4.9 | 5.7 | 6.5 | 7.3 | 8.1 | 49 |
| 50 | 18.9 | 19.7 | 20.5 | 21.3 | 22.1 | 22.9 | 23.7 | 24.6 | 25.4 | 26.2 | 27.0 | 27.9 | 28.7 | 50 |
| 51 | 9.3 | 20.1 | 0.9 | 1.8 | 2.6 | 3.5 | 4.3 | 5.1 | 6.0 | 6.8 | 7.6 | 8.5 | 9.4 | 51 |
| 52 | 9.7 | 0.6 | 1.4 | 2.3 | 3.1 | 4.0 | 4.9 | 5.7 | 6.6 | 7.5 | 8.3 | 9.2 | 30.1 | 52 |
| 53 | 20.2 | 1.1 | 1.9 | 2.8 | 3.7 | 4.6 | 5.5 | 6.4 | 7.3 | 8.2 | 9.0 | 30.0 | 0.9 | 53 |
| 54 | 0.7 | 1.6 | 2.5 | 3.4 | 4.3 | 5.2 | 6.1 | 7.1 | 8.0 | 8.9 | 9.8 | 0.8 | 1.7 | 54 |
| 55 | 21.2 | 22.2 | 23.1 | 24.0 | 24.9 | 25.9 | 26.8 | 27.8 | 28.7 | 29.7 | 30.6 | 31.6 | 32.6 | 55 |
| 56 | 1.8 | 2.8 | 3.7 | 4.7 | 5.6 | 6.6 | 7.6 | 8.6 | 9.5 | 30.5 | 1.5 | 2.5 | 3.6 | 56 |
| 57 | 2.4 | 3.4 | 4.4 | 5.4 | 6.4 | 7.4 | 8.4 | 9.4 | 30.4 | 1.4 | 2.5 | 3.5 | 4.6 | 57 |
| 58 | 3.1 | 4.1 | 5.1 | 6.1 | 7.2 | 8.2 | 9.2 | 30.3 | 1.3 | 2.4 | 3.5 | 4.6 | 5.7 | 58 |
| 59 | 3.8 | 4.8 | 5.9 | 6.9 | 8.0 | 9.1 | 30.2 | 1.3 | 2.3 | 3.5 | 4.6 | 5.7 | 6.9 | 59 |
| 60 | 24.6 | 25.6 | 26.7 | 27.8 | 28.9 | 30.1 | 31.2 | 32.3 | 33.4 | 34.6 | 35.8 | 36.9 | 38.2 | 60 |
| 61 | 5.4 | 6.5 | 7.6 | 8.8 | 9.9 | 1.1 | 2.2 | 3.5 | 4.6 | 5.8 | 7.1 | 8.3 | 9.6 | 61 |
| 62 | 6.3 | 7.5 | 8.6 | 9.8 | 31.0 | 2.2 | 3.4 | 4.7 | 5.9 | 7.2 | 8.5 | 9.8 | 41.2 | 62 |
| 63 | 7.2 | 8.5 | 9.7 | 31.0 | 2.2 | 3.5 | 4.7 | 6.1 | 7.4 | 8.7 | 40.1 | 41.5 | 2.9 | 63 |
| 64 | 8.3 | 9.6 | 30.9 | 2.2 | 3.5 | 4.8 | 6.2 | 7.6 | 9.0 | 40.4 | 1.8 | 3.3 | 4.8 | 64 |
| 65.0 | 29.5 | 30.8 | 32.2 | 33.5 | 34.9 | 36.3 | 37.8 | 39.2 | 40.7 | 42.2 | 43.8 | 45.4 | 47.0 | 65.0 |
| 5.5 | 30.1 | 1.5 | 2.9 | 4.3 | 5.7 | 7.1 | 8.6 | 40.1 | 1.6 | 3.2 | 4.8 | 6.5 | 8.2 | 5.5 |
| 6.0 | 0.7 | 2.2 | 3.6 | 5.0 | 6.5 | 8.0 | 9.5 | 1.1 | 2.7 | 4.3 | 5.9 | 7.7 | 9.4 | 6.0 |
| 6.5 | 1.4 | 2.9 | 4.3 | 5.8 | 7.3 | 8.9 | 40.5 | 2.1 | 3.8 | 5.4 | 7.1 | 8.9 | 50.8 | 6.5 |
| 7.0 | 2.1 | 3.6 | 5.1 | 6.7 | 8.2 | 9.8 | 1.5 | 3.2 | 4.9 | 6.6 | 8.4 | 50.3 | 2.3 | 7.0 |
| 67.5 | 32.9 | 34.4 | 36.0 | 37.6 | 39.2 | 40.8 | 42.6 | 44.3 | 46.1 | 47.9 | 49.8 | 51.8 | 53.9 | 67.5 |
| 8.0 | 3.7 | 5.3 | 6.9 | 8.6 | 40.2 | 1.9 | 3.7 | 5.5 | 7.4 | 9.3 | 51.3 | 3.4 | 5.6 | 8.0 |
| 8.5 | 4.6 | 6.2 | 7.9 | 9.6 | 1.3 | 3.1 | 4.9 | 6.8 | 8.8 | 50.8 | 2.9 | 5.1 | 7.5 | 8.5 |
| 9.0 | 5.5 | 7.2 | 8.9 | 40.7 | 2.5 | 4.3 | 6.2 | 8.2 | 50.3 | 2.4 | 4.6 | 7.0 | 9.6 | 9.0 |
| 9.5 | 6.4 | 8.2 | 40.0 | 1.8 | 3.7 | 5.6 | 7.6 | 9.7 | 1.9 | 4.2 | 6.5 | 9.1 | 61.9 | 9.5 |
| 70.0 | 37.4 | 39.3 | 41.1 | 43.0 | 45.0 | 47.0 | 49.2 | 51.4 | 53.7 | 56.1 | 58.7 | 61.5 | 64.6 | 70.0 |
| 0.5 | 8.5 | 40.4 | 2.4 | 4.4 | 6.4 | 8.6 | 50.8 | 3.2 | 5.7 | 8.3 | 61.1 | 4.3 | 7.8 | 0.5 |
| 1.0 | 9.7 | 1.7 | 3.7 | 5.8 | 8.0 | 50.3 | 2.6 | 5.2 | 7.9 | 60.7 | 3.9 | 7.5 | 71.7 | 1.0 |
| 1.5 | 40.9 | 3.0 | 5.1 | 7.4 | 9.7 | 2.1 | 4.6 | 7.4 | 60.3 | 3.5 | 7.1 | 71.4 | 6.9 | 1.5 |
| 2.0 | 2.3 | 4.4 | 6.7 | 9.1 | 51.5 | 4.1 | 6.9 | 9.9 | 3.1 | 6.8 | 71.1 | 6.7 | 90.0 | 2.0 |
| 72.5 | 43.7 | 46.0 | 48.4 | 50.9 | 53.6 | 56.4 | 59.4 | 62.7 | 66.4 | 70.9 | 76.5 | 90.0 | | 72.5 |
| 3.0 | 5.3 | 7.7 | 50.3 | 3.0 | 5.9 | 8.9 | 62.2 | 6.1 | 70.6 | 6.3 | 90.0 | | | 3.0 |
| 3.5 | 7.0 | 9.6 | 2.3 | 5.3 | 8.4 | 61.8 | 5.6 | 70.3 | 6.1 | 90.0 | | | | 3.5 |
| 4.0 | 8.9 | 51.7 | 4.7 | 7.9 | 61.4 | 5.3 | 9.8 | 75.9 | 90.0 | | | | | 4.0 |
| 4.5 | 51.1 | 4.1 | 7.3 | 60.9 | 4.9 | 9.5 | 75.5 | 90.0 | | | | | | 4.5 |

TABLE 39. [Page 579

Amplitudes.

| Latitude. | Declination. | | | | | | | | | | | | | Latitude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18°.0 | 18°.5 | 19°.0 | 19°.5 | 20°.0 | 20°.5 | 21°.0 | 21°.5 | 22°.0 | 22°.5 | 23°.0 | 23°.5 | 24°.0 | |
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0 | 18.0 | 18.5 | 19.0 | 19.5 | 20.0 | 20.5 | 21.0 | 21.5 | 22.0 | 22.5 | 23.0 | 23.5 | 24.0 | 0 |
| 10 | 8.3 | 8.8 | 9.3 | 9.8 | 0.3 | 0.8 | 1.3 | 1.8 | 2.3 | 2.9 | 3.4 | 3.9 | 4.4 | 10 |
| 15 | 8.7 | 9.2 | 9.7 | 20.2 | 0.7 | 1.3 | 1.8 | 2.3 | 2.8 | 3.3 | 3.9 | 4.4 | 4.9 | 15 |
| 20 | 9.2 | 9.7 | 20.3 | 0.8 | 1.4 | 1.9 | 2.4 | 3.0 | 3.5 | 4.0 | 4.6 | 5.1 | 5.7 | 20 |
| 25 | 9.9 | 20.5 | 1.1 | 1.6 | 2.2 | 2.7 | 3.3 | 3.9 | 4.4 | 5.0 | 5.5 | 6.1 | 6.7 | 25 |
| 30 | 20.9 | 21.5 | 22.1 | 22.7 | 23.3 | 23.8 | 24.4 | 25.0 | 25.6 | 26.2 | 26.8 | 27.4 | 28.0 | 30 |
| 32 | 1.4 | 2.0 | 2.6 | 3.2 | 3.8 | 4.4 | 5.0 | 5.6 | 6.2 | 6.8 | 7.4 | 8.0 | 8.7 | 32 |
| 34 | 1.9 | 2.5 | 3.1 | 3.8 | 4.4 | 5.0 | 5.6 | 6.2 | 6.9 | 7.5 | 8.1 | 8.7 | 9.4 | 34 |
| 36 | 2.5 | 3.1 | 3.7 | 4.4 | 5.0 | 5.7 | 6.3 | 6.9 | 7.6 | 8.2 | 8.9 | 9.5 | 30.2 | 36 |
| 38 | 3.1 | 3.8 | 4.4 | 5.1 | 5.7 | 6.4 | 7.0 | 7.7 | 8.4 | 9.1 | 9.7 | 30.4 | 1.1 | 38 |
| 40 | 23.9 | 24.4 | 25.1 | 25.8 | 26.5 | 27.2 | 27.9 | 28.6 | 29.3 | 30.0 | 30.7 | 31.3 | 32.1 | 40 |
| 41 | 4.2 | 4.8 | 5.5 | 6.2 | 6.9 | 7.7 | 8.3 | 9.1 | 9.8 | 0.5 | 1.2 | 1.8 | 2.6 | 41 |
| 42 | 4.6 | 5.3 | 6.0 | 6.7 | 7.4 | 8.1 | 8.8 | 9.6 | 30.3 | 1.0 | 1.7 | 2.4 | 3.2 | 42 |
| 43 | 5.0 | 5.7 | 6.4 | 7.2 | 7.9 | 8.6 | 9.3 | 30.1 | 0.8 | 1.6 | 2.3 | 3.0 | 3.8 | 43 |
| 44 | 5.4 | 6.2 | 6.9 | 7.7 | 8.4 | 9.1 | 9.8 | 0.6 | 1.4 | 2.2 | 2.9 | 3.6 | 4.4 | 44 |
| 45 | 25.9 | 26.7 | 27.4 | 28.2 | 28.9 | 29.7 | 30.4 | 31.2 | 32.0 | 32.8 | 33.5 | 34.3 | 35.1 | 45 |
| 46 | 6.4 | 7.2 | 7.9 | 8.7 | 9.5 | 30.3 | 1.0 | 1.8 | 2.6 | 3.4 | 4.2 | 5.0 | 5.8 | 46 |
| 47 | 6.9 | 7.7 | 8.5 | 9.3 | 30.1 | 0.9 | 1.7 | 2.5 | 3.3 | 4.1 | 4.9 | 5.7 | 6.6 | 47 |
| 48 | 7.5 | 8.3 | 9.1 | 9.9 | 0.7 | 1.6 | 2.4 | 3.2 | 4.0 | 4.9 | 5.7 | 6.5 | 7.4 | 48 |
| 49 | 8.1 | 8.9 | 9.7 | 30.6 | 1.4 | 2.3 | 3.1 | 4.0 | 4.8 | 5.7 | 6.5 | 7.4 | 8.3 | 49 |
| 50 | 28.7 | 29.6 | 30.4 | 31.3 | 32.1 | 33.0 | 33.9 | 34.8 | 35.6 | 36.5 | 37.4 | 38.3 | 39.2 | 50 |
| 51 | 9.4 | 30.3 | 1.1 | 2.0 | 2.9 | 3.8 | 4.7 | 5.6 | 6.5 | 7.4 | 8.4 | 9.3 | 40.2 | 51 |
| 52 | 30.1 | 1.0 | 1.9 | 2.8 | 3.7 | 4.7 | 5.6 | 6.5 | 7.5 | 8.4 | 9.4 | 40.3 | 1.3 | 52 |
| 53 | 0.9 | 1.8 | 2.7 | 3.7 | 4.6 | 5.6 | 6.6 | 7.5 | 8.5 | 9.5 | 40.5 | 1.4 | 2.5 | 53 |
| 54 | 1.7 | 2.7 | 3.6 | 4.6 | 5.6 | 6.6 | 7.6 | 8.6 | 9.6 | 40.6 | 1.7 | 2.6 | 3.8 | 54 |
| 55 | 32.6 | 33.6 | 34.6 | 35.6 | 36.6 | 37.6 | 38.7 | 39.7 | 40.8 | 41.9 | 42.9 | 44.0 | 45.2 | 55 |
| 56 | 3.6 | 4.6 | 5.6 | 6.7 | 7.7 | 8.8 | 9.8 | 41.0 | 2.1 | 3.2 | 4.3 | 5.4 | 6.7 | 56 |
| 57 | 4.6 | 5.6 | 6.7 | 7.8 | 8.9 | 40.0 | 41.1 | 2.3 | 3.5 | 4.6 | 5.8 | 7.0 | 8.3 | 57 |
| 58 | 5.7 | 6.8 | 7.9 | 9.1 | 40.2 | 1.4 | 2.5 | 3.8 | 5.0 | 6.2 | 7.5 | 8.8 | 50.1 | 58 |
| 59 | 6.9 | 8.0 | 9.2 | 40.4 | 1.6 | 2.8 | 4.1 | 5.4 | 6.7 | 8.0 | 9.3 | 50.7 | 2.2 | 59 |
| 60.0 | 38.2 | 39.4 | 40.6 | 41.9 | 43.2 | 44.5 | 45.8 | 47.2 | 48.6 | 49.9 | 51.4 | 52.9 | 54.4 | 60.0 |
| 0.5 | 8.9 | 40.1 | 1.4 | 2.7 | 4.0 | 5.4 | 6.7 | 8.1 | 9.6 | 51.0 | 2.5 | 4.1 | 5.7 | 0.5 |
| 1.0 | 9.6 | 0.9 | 2.2 | 3.5 | 4.9 | 6.3 | 7.7 | 9.1 | 50.6 | 2.1 | 3.7 | 5.3 | 7.0 | 1.0 |
| 1.5 | 40.4 | 1.7 | 3.0 | 4.4 | 5.8 | 7.3 | 8.7 | 50.2 | 1.7 | 3.3 | 5.0 | 6.7 | 8.5 | 1.5 |
| 2.0 | 1.2 | 2.5 | 3.9 | 5.3 | 6.8 | 8.3 | 9.8 | 1.3 | 2.9 | 4.6 | 6.3 | 8.1 | 60.0 | 2.0 |
| 62.5 | 42.0 | 43.4 | 44.9 | 46.3 | 47.8 | 49.4 | 51.0 | 52.6 | 54.2 | 56.0 | 57.8 | 59.7 | 61.7 | 62.5 |
| 3.0 | 2.9 | 4.3 | 5.9 | 7.4 | 8.9 | 50.5 | 2.2 | 3.9 | 5.6 | 7.5 | -9.4 | 61.4 | 3.6 | 3.0 |
| 3.5 | 3.8 | 5.3 | 6.9 | 8.5 | 50.1 | 1.7 | 3.5 | 5.3 | 7.1 | 9.1 | 61.1 | 3.4 | 5.7 | 3.5 |
| 4.0 | 4.8 | 6.4 | 8.0 | 9.7 | 1.3 | 3.0 | 4.9 | 6.7 | 8.7 | 60.7 | 3.0 | 5.5 | 8.1 | 4.0 |
| 4.5 | 5.9 | 7.5 | 9.2 | 50.9 | 2.6 | 4.5 | 6.4 | 8.4 | 60.5 | 2.8 | 5.2 | 7.8 | 70.9 | 4.5 |
| 65.0 | 47.0 | 48.7 | 50.4 | 52.2 | 54.0 | 56.0 | 58.0 | 60.2 | 62.5 | 64.9 | 67.6 | 70.6 | 74.4 | 65.0 |
| 5.5 | 8.2 | 50.0 | 1.8 | 3.6 | 5.6 | 7.6 | 9.8 | 2.2 | 4.7 | 7.3 | 70.4 | 4.1 | 8.9 | 5.5 |
| 6.0 | 9.4 | 1.3 | 3.2 | 5.1 | 7.3 | 9.4 | 61.8 | 4.4 | 7.1 | 70.2 | 3.8 | 8.6 | 90.0 | 6.0 |
| 6.5 | 50.8 | 2.7 | 4.7 | 6.8 | 9.1 | 61.4 | 4.0 | 6.8 | 70.0 | 3.7 | 8.4 | 90.0 | | 6.5 |
| 7.0 | 2.3 | 4.3 | 6.4 | 8.7 | 61.1 | 3.7 | 6.5 | 9.8 | 3.5 | 8.3 | 90.0 | | | 7.0 |
| 67.5 | 53.9 | 56.0 | 58.3 | 60.7 | 63.4 | 66.2 | 69.5 | 73.3 | 78.2 | 90.0 | | | | 67.5 |
| 8.0 | 5.6 | 7.9 | 60.3 | 3.0 | 5.9 | 9.2 | 73.0 | 8.1 | 90.0 | | | | | 8.0 |
| 8.5 | 7.5 | 60.0 | 2.6 | 5.6 | 8.9 | 72.8 | 7.9 | 90.0 | | | | | | 8.5 |
| 9.0 | 9.6 | 2.3 | 5.3 | 8.7 | 72.7 | .7.7 | 90.0 | | | | | | | 9.0 |
| 9.5 | 61.9 | 5.0 | 8.4 | 72.4 | 7.6 | 90.0 | | | | | | | | 9.5 |
| 70.0 | 64.6 | 69.1 | 72.2 | 77.4 | 90.0 | | | | | | | | | 70.0 |
| 0.5 | 7.8 | 71.9 | 7.2 | 90.0 | | | | | | | | | | 0.5 |
| 1.0 | 71.7 | 7.1 | 90.0 | | | | | | | | | | | 1.0 |
| 1.5 | 6.9 | 90.0 | | | | | | | | | | | | 1.5 |
| 2.0 | 90.0 | | | | | | | | | | | | | 2.0 |

# TABLE 39.

## Amplitudes.

| Lati-tude. | 24°.0 | 24°.5 | 25°.0 | 25°.5 | 26°.0 | 26°.5 | 27°.0 | 27°.5 | 28°.0 | 28°.5 | 29°.0 | 29°.5 | 30°.0 | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 24.0 | 24.5 | 25.0 | 25.5 | 26.0 | 26.5 | 27.0 | 27.5 | 28.0 | 28.5 | 29.0 | 29.5 | 30.0 | 0 |
| 4 | 4.1 | 4.6 | 5.1 | 5.6 | 6.1 | 6.6 | 7.1 | 7.6 | 8.1 | 8.6 | 9.1 | 9.6 | 0.1 | 4 |
| 8 | 4.3 | 4.8 | 5.3 | 5.8 | 6.3 | 6.8 | 7.3 | 7.8 | 8.3 | 8.8 | 9.3 | 9.8 | 0.3 | 8 |
| 12 | 4.6 | 5.1 | 5.6 | 6.1 | 6.6 | 7.1 | 7.6 | 8.1 | 8.7 | 9.2 | 9.7 | 30.2 | 0.7 | 12 |
| 16 | 5.0 | 5.6 | 6.1 | 6.6 | 7.1 | 7.6 | 8.2 | 8.7 | 9.2 | 9.8 | 30.3 | 0.8 | 1.3 | 16 |
| 20 | 25.7 | 26.2 | 26.7 | 27.3 | 27.8 | 28.3 | 28.9 | 29.4 | 30.0 | 30.5 | 31.1 | 31.6 | 32.1 | 20 |
| 22 | 6.0 | 6.6 | 7.1 | 7.7 | 8.2 | 8.8 | 9.3 | 9.9 | 0.4 | 1.0 | 1.5 | 2.1 | 2.6 | 22 |
| 24 | 6.4 | 7.0 | 7.6 | 8.1 | 8.7 | 9.2 | 9.8 | 30.4 | 0.9 | 1.5 | 2.0 | 2.6 | 3.2 | 24 |
| 26 | 6.9 | 7.5 | 8.1 | 8.6 | 9.2 | 9.7 | 30.3 | 0.9 | 1.5 | 2.1 | 2.6 | 3.2 | 3.8 | 26 |
| 28 | 7.4 | 8.0 | 8.6 | 9.2 | 9.8 | 30.3 | 0.9 | 1.5 | 2.1 | 2.7 | 3.3 | 3.9 | 4.5 | 28 |
| 30 | 28.0 | 28.6 | 29.2 | 29.8 | 30.4 | 31.0 | 31.6 | 32.2 | 32.8 | 33.4 | 34.0 | 34.7 | 35.3 | 30 |
| 31 | 8.3 | 8.9 | 9.5 | 30.1 | 0.8 | 1.4 | 2.0 | 2.6 | 3.2 | 3.8 | 4.5 | 5.1 | 5.7 | 31 |
| 32 | 8.7 | 9.3 | 9.9 | 0.5 | 1.1 | 1.7 | 2.4 | 3.0 | 3.6 | 4.2 | 4.9 | 5.5 | 6.1 | 32 |
| 33 | 9.0 | 9.6 | 30.2 | 0.9 | 1.5 | 2.1 | 2.8 | 3.4 | 4.0 | 4.7 | 5.3 | 6.0 | 6.6 | 33 |
| 34 | 9.4 | 30.0 | 0.6 | 31.3 | 1.9 | 2.6 | 3.2 | 3.8 | 4.5 | 5.1 | 5.8 | 6.4 | 7.1 | 34 |
| 35 | 29.8 | 30.4 | 31.1 | 31.7 | 32.3 | 33.0 | 33.6 | 34.3 | 35.0 | 35.6 | 36.3 | 36.9 | 37.6 | 35 |
| 36 | 30.2 | 0.8 | 1.5 | 2.1 | 2.8 | 3.5 | 4.1 | 4.8 | 5.5 | 6.1 | 6.8 | 7.5 | 8.2 | 36 |
| 37 | 0.6 | 1.3 | 1.9 | 2.6 | 3.3 | 4.0 | 4.6 | 5.3 | 6.0 | 6.7 | 7.4 | 8.1 | 8.8 | 37 |
| 38 | 1.1 | 1.7 | 2.4 | 3.1 | 3.8 | 4.5 | 5.2 | 5.9 | 6.6 | 7.3 | 8.0 | 8.7 | 9.4 | 38 |
| 39 | 1.6 | 2.2 | 2.9 | 3.6 | 4.3 | 5.0 | 5.7 | 6.5 | 7.2 | 7.9 | 8.6 | 9.3 | 40.0 | 39 |
| 40 | 32.1 | 32.8 | 33.5 | 34.2 | 34.9 | 35.6 | 36.3 | 37.1 | 37.8 | 38.5 | 39.3 | 40.0 | 40.7 | 40 |
| 41 | 2.6 | 3.3 | 4.1 | 4.8 | 5.5 | 6.2 | 7.0 | 7.7 | 8.5 | 9.2 | 40.0 | 0.7 | 1.5 | 41 |
| 42 | 3.2 | 3.9 | 4.7 | 5.4 | 6.1 | 6.9 | 7.7 | 8.4 | 9.2 | 9.9 | 0.7 | 1.5 | 2.3 | 42 |
| 43 | 3.8 | 4.5 | 5.3 | 6.1 | 6.8 | 7.6 | 8.4 | 9.2 | 9.9 | 40.7 | 1.5 | 2.3 | 3.1 | 43 |
| 44 | 4.4 | 5.2 | 6.0 | 6.8 | 7.5 | 8.3 | 9.1 | 40.0 | 40.7 | 1.6 | 2.4 | 3.2 | 4.0 | 44 |
| 45 | 35.1 | 35.9 | 36.7 | 37.5 | 38.3 | 39.1 | 39.9 | 40.8 | 41.6 | 42.5 | 43.3 | 44.1 | 45.0 | 45 |
| 46 | 5.8 | 6.6 | 7.5 | 8.3 | 9.1 | 40.0 | 40.8 | 1.7 | 2.5 | 3.4 | 4.3 | 5.1 | 6.0 | 46 |
| 47 | 6.6 | 7.4 | 8.3 | 9.1 | 40.0 | 0.9 | 1.7 | 2.6 | 3.5 | 4.4 | 5.3 | 6.2 | 7.1 | 47 |
| 48 | 7.4 | 8.3 | 9.2 | 40.0 | 0.9 | 1.8 | 2.7 | 3.6 | 4.6 | 5.5 | 6.4 | 7.4 | 8.3 | 48 |
| 49 | 8.3 | 9.2 | 40.1 | 1.0 | 1.9 | 2.8 | 3.8 | 4.7 | 5.7 | 6.7 | 7.6 | 8.6 | 9.6 | 49 |
| 50 | 39.2 | 40.2 | 41.1 | 42.0 | 43.0 | 43.9 | 44.9 | 45.9 | 46.9 | 47.9 | 48.9 | 50.0 | 51.1 | 50 |
| 51 | 40.2 | 1.2 | 2.2 | 3.2 | 4.1 | 5.1 | 6.2 | 7.2 | 8.2 | 9.3 | 50.4 | 1.5 | 2.6 | 51 |
| 52 | 1.3 | 2.3 | 3.3 | 4.4 | 5.4 | 6.4 | 7.5 | 8.6 | 9.7 | 50.8 | 2.0 | 3.1 | 4.3 | 52 |
| 53 | 2.5 | 3.5 | 4.6 | 5.7 | 6.7 | 7.8 | 9.0 | 50.1 | 51.3 | 2.5 | 3.7 | 4.9 | 6.2 | 53 |
| 54 | 3.8 | 4.9 | 6.0 | 7.1 | 8.2 | 9.4 | 50.6 | 1.8 | 3.0 | 4.3 | 5.6 | 6.9 | 8.3 | 54 |
| 55.0 | 45.2 | 46.3 | 47.5 | 48.6 | 49.8 | 51.1 | 52.3 | 53.6 | 54.9 | 56.3 | 57.7 | 59.1 | 60.7 | 55.0 |
| 5.5 | 5.9 | 7.1 | 8.3 | 9.5 | 50.7 | 2.0 | 3.3 | 4.6 | 6.0 | 7.4 | 8.9 | 60.4 | 2.0 | 5.5 |
| 6.0 | 6.7 | 7.9 | 9.1 | 50.4 | 1.6 | 2.9 | 4.3 | 5.7 | 7.1 | 8.6 | 60.1 | 1.7 | 3.4 | 6.0 |
| 6.5 | 7.5 | 8.8 | 50.0 | 1.3 | 2.6 | 3.9 | 5.4 | 6.8 | 8.3 | 9.9 | 1.5 | 3.2 | 5.0 | 6.5 |
| 7.0 | 8.3 | 9.6 | 0.9 | 2.2 | 3.6 | 5.0 | 6.5 | 8.0 | 9.5 | 61.2 | 2.9 | 4.7 | 6.6 | 7.0 |
| 57.5 | 49.2 | 50.5 | 51.9 | 53.2 | 54.7 | 56.2 | 57.7 | 59.3 | 60.9 | 62.6 | 64.5 | 66.4 | 68.5 | 57.5 |
| 8.0 | 50.1 | 1.5 | 2.9 | 4.3 | 5.8 | 7.4 | 8.9 | 60.6 | 2.4 | 4.2 | 6.2 | 8.3 | 70.7 | 8.0 |
| 8.5 | 1.1 | 2.5 | 4.0 | 5.5 | 7.0 | 8.6 | 60.3 | 2.1 | 3.9 | 6.0 | 8.1 | 70.4 | 3.1 | 8.5 |
| 9.0 | 2.2 | 3.6 | 5.1 | 6.7 | 8.3 | 60.0 | 1.8 | 3.7 | 5.7 | 7.9 | 70.3 | 3.0 | 6.2 | 9.0 |
| 9.5 | 3.3 | 4.8 | 6.4 | 8.0 | 9.7 | 1.5 | 3.4 | 5.5 | 7.7 | 70.1 | 2.8 | 5.9 | 80.1 | 9.5 |
| 60.0 | 54.4 | 56.0 | 57.7 | 59.4 | 61.2 | 63.2 | 65.2 | 67.4 | 69.9 | 72.6 | 75.8 | 80.0 | 90.0 | 60.0 |
| 0.5 | 5.7 | 7.4 | 9.1 | 61.0 | 2.9 | 5.0 | 7.2 | 9.6 | 72.4 | 5.8 | 9.9 | 90.0 | | 0.5 |
| 1.0 | 7.0 | 8.8 | 60.7 | 2.6 | 4.7 | 7.0 | 9.5 | 72.3 | 5.5 | 9.8 | 90.0 | | | 1.0 |
| 1.5 | 8.5 | 60.3 | 2.3 | 4.4 | 6.7 | 9.2 | 72.0 | 5.4 | 9.7 | 90.0 | | | | 1.5 |
| 2.0 | 60.0 | 2.0 | 4.2 | 6.5 | 9.0 | 71.9 | 5.2 | 9.6 | 90.0 | | | | | 2.0 |
| 62.5 | 61.7 | 63.9 | 66.2 | 68.8 | 71.7 | '75.1 | 9.5 | 90.0 | | | | | | 62.5 |
| 3.0 | 3.6 | '6.0 | 8.6 | 71.5 | 4.9 | 9.4 | 90.0 | | | | | | | 3.0 |
| 3.5 | 5.7 | 8.3 | 71.3 | 4.8 | 9.3 | 90.0 | | | | | | | | 3.5 |
| 4.0 | 8.1 | 71.1 | 4.6 | 9.2 | 90.0 | | | | | | | | | 4.0 |
| 4.5 | 70.9 | 4.4 | 9.0 | 90.0 | | | | | | | | | | 4.5 |

TABLE 40. [Page 581

Correction of the Amplitude as observed on the Apparent Horizon.

| Lati-tude. | Declination. | | | | | | | | | | | | | Lati-tude. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0° | 5° | 10° | 12° | 14° | 16° | 18° | 20° | 22° | 24° | 26° | 28° | 30° | |
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ' | ° |
| 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| 5 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1- | .1 | .1 | .1 | 5 |
| 10 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | 10 |
| 15 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | 15 |
| 20 | .2 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | 20 |
| 24 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 24 |
| 28 | .3 | .4 | .4 | .4 | .4 | .4 | .4 | .4 | .4 | .4 | .4 | .4 | .4 | 28 |
| 32 | .4 | .4 | .4 | .4 | .4 | .4 | .4 | .5 | .5 | .5 | .5 | .5 | .5 | 32 |
| 36 | .5 | .5 | .5 | .5 | .5 | .5 | .5 | .5 | .6 | .6 | .6 | .6 | .6 | 36 |
| 38 | .5 | .5 | .5 | .5 | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .7 | .7 | 38 |
| 40 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 40 |
| 42 | .6 | .6 | .6 | .6 | .6 | .7 | .7 | .7 | .7 | .7 | .8 | .8 | .8 | 42 |
| 44 | .6 | .6 | .7 | .7 | .7 | .7 | .7 | .7 | .8 | .8 | .8 | .9 | .9 | 44 |
| 46 | .7 | .7 | .7 | .7 | .7 | .8 | .8 | .8 | .8 | .9 | .9 | .9 | 1.0 | 46 |
| 48 | .7 | .8 | .8 | .8 | .8 | .8 | .8 | .9 | .9 | 1.0 | 1.0 | 1.0 | .1 | 48 |
| 50 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 1.1 | 1.1 | 1.1 | 1.3 | 50 |
| 52 | .8 | .9 | .9 | .9 | .9 | 1.0 | 1.0 | 1.0 | .1 | .2 | .2 | .3 | .5 | 52 |
| 54 | .9 | .9 | 1.0 | 1.0 | 1.0 | .1 | .1 | .1 | .2 | .3 | .4 | .5 | .8 | 54 |
| 56 | 1.0 | 1.0 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .5 | .6 | .8 | 2.2 | 56 |
| 58 | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .4 | .5 | .7 | .9 | 2.3 | 3.2 | 58 |
| 60 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 2.0 | 2.4 | 3.4 | | 60 |
| 62 | .3 | .3 | .4 | .4 | .4 | .6 | .7 | .8 | 2.1 | .5 | 3.5 | | | 62 |
| 64 | .4 | .4 | .5 | .5 | .6 | .8 | .9 | 2.2 | .6 | 3.7 | | | | 64 |
| 66 | .5 | .5 | .7 | .7 | .9 | 2.0 | 2.3 | .8 | 3.8 | | | | | 66 |
| 68 | .6 | .7 | .9 | 2.0 | 2.2 | .4 | .9 | 4.0 | | | | | | 68 |
| 70 | 1.8 | 1.9 | 2.1 | 2.3 | 2.6 | 3.1 | 4.3 | | | | | | | 70 |
| 72 | 2.0 | 2.1 | .5 | .8 | 3.3 | 4.6 | | | | | | | | 72 |
| 74 | .2 | .5 | 3.0 | 3.5 | 4.8 | | | | | | | | | 74 |
| 76 | .6 | 3.0 | .8 | 5.2 | | | | | | | | | | 76 |
| 78 | 3.1 | .6 | 5.7 | | | | | | | | | | | 78 |
| 80 | 3.8 | 4.4 | | | | | | | | | | | | 80 |

# TABLE 41.

## Natural Sines and Cosines.

| Prop. parts 29 | M. | 0° N. sine. | 0° N. cos. | 1° N. sine. | 1° N. cos. | 2° N. sine. | 2° N. cos. | 3° N. sine. | 3° N. cos. | 4° N. sine | 4° N. cos. | | Prop. parts 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 00000 | 100000 | 01745 | 99985 | 03490 | 99939 | 05234 | 99863 | 06976 | 99756 | 60 | 2 |
| 0 | 1 | 00029 | 100000 | 01774 | 99984 | 03519 | 99938 | 05263 | 99861 | 07005 | 99754 | 59 | 2 |
| 1 | 2 | 00058 | 100000 | 01803 | 99984 | 03548 | 99937 | 05292 | 99860 | 07034 | 99752 | 58 | 2 |
| 1 | 3 | 00087 | 100000 | 01832 | 99983 | 03577 | 99936 | 05321 | 99858 | 07063 | 99750 | 57 | 2 |
| 2 | 4 | 00116 | 100000 | 01862 | 99983 | 03606 | 99935 | 05350 | 99857 | 07092 | 99748 | 56 | 2 |
| 2 | 5 | 00145 | 100000 | 01891 | 99982 | 03635 | 99934 | 05379 | 99855 | 07121 | 99746 | 55 | 2 |
| 3 | 6 | 00175 | 100000 | 01920 | 99982 | 03664 | 99933 | 05408 | 99854 | 07150 | 99744 | 54 | 2 |
| 3 | 7 | 00204 | 100000 | 01949 | 99981 | 03693 | 99932 | 05437 | 99852 | 07179 | 99742 | 53 | 2 |
| 4 | 8 | 00233 | 100000 | 01978 | 99980 | 03723 | 99931 | 05466 | 99851 | 07208 | 99740 | 52 | 2 |
| 4 | 9 | 00262 | 100000 | 02007 | 99980 | 03752 | 99930 | 05495 | 99849 | 07237 | 99738 | 51 | 2 |
| 5 | 10 | 00291 | 100000 | 02036 | 99979 | 03781 | 99929 | 05524 | 99847 | 07266 | 99736 | 50 | 2 |
| 5 | 11 | 00320 | 99999 | 02065 | 99979 | 03810 | 99927 | 05553 | 99846 | 07295 | 99734 | 49 | 2 |
| 6 | 12 | 00349 | 99999 | 02094 | 99978 | 03839 | 99926 | 05582 | 99844 | 07324 | 99731 | 48 | 2 |
| 6 | 13 | 00378 | 99999 | 02123 | 99977 | 03868 | 99925 | 05611 | 99842 | 07353 | 99729 | 47 | 2 |
| 7 | 14 | 00407 | 99999 | 02152 | 99977 | 03897 | 99924 | 05640 | 99841 | 07382 | 99727 | 46 | 2 |
| 7 | 15 | 00436 | 99999 | 02181 | 99976 | 03926 | 99923 | 05669 | 99839 | 07411 | 99725 | 45 | 2 |
| 8 | 16 | 00465 | 99999 | 02211 | 99976 | 03955 | 99922 | 05698 | 99838 | 07440 | 99723 | 44 | 1 |
| 8 | 17 | 00495 | 99999 | 02240 | 99975 | 03984 | 99921 | 05727 | 99836 | 07469 | 99721 | 43 | 1 |
| 9 | 18 | 00524 | 99999 | 02269 | 99974 | 04013 | 99919 | 05756 | 99834 | 07498 | 99719 | 42 | 1 |
| 9 | 19 | 00553 | 99998 | 02298 | 99974 | 04042 | 99918 | 05785 | 99833 | 07527 | 99716 | 41 | 1 |
| 10 | 20 | 00582 | 99998 | 02327 | 99973 | 04071 | 99917 | 05814 | 99831 | 07556 | 99714 | 40 | 1 |
| 10 | 21 | 00611 | 99998 | 02356 | 99972 | 04100 | 99916 | 05844 | 99829 | 07585 | 99712 | 39 | 1 |
| 11 | 22 | 00640 | 99998 | 02385 | 99972 | 04129 | 99915 | 05873 | 99827 | 07614 | 99710 | 38 | 1 |
| 11 | 23 | 00669 | 99998 | 02414 | 99971 | 04159 | 99913 | 05902 | 99826 | 07643 | 99708 | 37 | 1 |
| 12 | 24 | 00698 | 99998 | 02443 | 99970 | 04188 | 99912 | 05931 | 99824 | 07672 | 99705 | 36 | 1 |
| 12 | 25 | 00727 | 99997 | 02472 | 99969 | 04217 | 99911 | 05960 | 99822 | 07701 | 99703 | 35 | 1 |
| 13 | 26 | 00756 | 99997 | 02501 | 99969 | 04246 | 99910 | 05989 | 99821 | 07730 | 99701 | 34 | 1 |
| 13 | 27 | 00785 | 99997 | 02530 | 99968 | 04275 | 99909 | 06018 | 99819 | 07759 | 99699 | 33 | 1 |
| 14 | 28 | 00814 | 99997 | 02560 | 99967 | 04304 | 99907 | 06047 | 99817 | 07788 | 99696 | 32 | 1 |
| 14 | 29 | 00844 | 99996 | 02589 | 99966 | 04333 | 99906 | 06076 | 99815 | 07817 | 99694 | 31 | 1 |
| 15 | 30 | 00873 | 99996 | 02618 | 99966 | 04362 | 99905 | 06105 | 99813 | 07846 | 99692 | 30 | 1 |
| 15 | 31 | 00902 | 99996 | 02647 | 99965 | 04391 | 99904 | 06134 | 99812 | 07875 | 99689 | 29 | 1 |
| 15 | 32 | 00931 | 99996 | 02676 | 99964 | 04420 | 99902 | 06163 | 99810 | 07904 | 99687 | 28 | 1 |
| 16 | 33 | 00960 | 99995 | 02705 | 99963 | 04449 | 99901 | 06192 | 99808 | 07933 | 99685 | 27 | 1 |
| 16 | 34 | 00989 | 99995 | 02734 | 99963 | 04478 | 99900 | 06221 | 99806 | 07962 | 99683 | 26 | 1 |
| 17 | 35 | 01018 | 99995 | 02763 | 99962 | 04507 | 99898 | 06250 | 99804 | 07991 | 99680 | 25 | 1 |
| 17 | 36 | 01047 | 99995 | 02792 | 99961 | 04536 | 99897 | 06279 | 99803 | 08020 | 99678 | 24 | 1 |
| 18 | 37 | 01076 | 99994 | 02821 | 99960 | 04565 | 99896 | 06308 | 99801 | 08049 | 99676 | 23 | 1 |
| 18 | 38 | 01105 | 99994 | 02850 | 99959 | 04594 | 99894 | 06337 | 99799 | 08078 | 99673 | 22 | 1 |
| 19 | 39 | 01134 | 99994 | 02879 | 99959 | 04623 | 99893 | 06366 | 99797 | 08107 | 99671 | 21 | 1 |
| 19 | 40 | 01164 | 99993 | 02908 | 99958 | 04653 | 99892 | 06395 | 99795 | 08136 | 99668 | 20 | 1 |
| 20 | 41 | 01193 | 99993 | 02938 | 99957 | 04682 | 99890 | 06424 | 99793 | 08165 | 99666 | 19 | 1 |
| 20 | 42 | 01222 | 99993 | 02967 | 99956 | 04711 | 99889 | 06453 | 99792 | 08194 | 99664 | 18 | 1 |
| 21 | 43 | 01251 | 99992 | 02996 | 99955 | 04740 | 99888 | 06482 | 99790 | 08223 | 99661 | 17 | 1 |
| 21 | 44 | 01280 | 99992 | 03025 | 99954 | 04769 | 99886 | 06511 | 99788 | 08252 | 99659 | 16 | 1 |
| 22 | 45 | 01309 | 99991 | 03054 | 99953 | 04798 | 99885 | 06540 | 99786 | 08281 | 99657 | 15 | 1 |
| 22 | 46 | 01338 | 99991 | 03083 | 99952 | 04827 | 99883 | 06569 | 99784 | 08310 | 99654 | 14 | 0 |
| 23 | 47 | 01367 | 99991 | 03112 | 99952 | 04856 | 99882 | 06598 | 99782 | 08339 | 99652 | 13 | 0 |
| 23 | 48 | 01396 | 99990 | 03141 | 99951 | 04885 | 99881 | 06627 | 99780 | 08368 | 99649 | 12 | 0 |
| 24 | 49 | 01425 | 99990 | 03170 | 99950 | 04914 | 99879 | 06656 | 99778 | 08397 | 99647 | 11 | 0 |
| 24 | 50 | 01454 | 99989 | 03199 | 99949 | 04943 | 99878 | 06685 | 99776 | 08426 | 99644 | 10 | 0 |
| 25 | 51 | 01483 | 99989 | 03228 | 99948 | 04972 | 99876 | 06714 | 99774 | 08455 | 99642 | 9 | 0 |
| 25 | 52 | 01513 | 99989 | 03257 | 99947 | 05001 | 99875 | 06743 | 99772 | 08484 | 99639 | 8 | 0 |
| 26 | 53 | 01542 | 99988 | 03286 | 99946 | 05030 | 99873 | 06773 | 99770 | 08513 | 99637 | 7 | 0 |
| 26 | 54 | 01571 | 99988 | 03316 | 99945 | 05059 | 99872 | 06802 | 99768 | 08542 | 99635 | 6 | 0 |
| 27 | 55 | 01600 | 99987 | 03345 | 99944 | 05088 | 99870 | 06831 | 99766 | 08571 | 99632 | 5 | 0 |
| 27 | 56 | 01629 | 99987 | 03374 | 99943 | 05117 | 99869 | 06860 | 99764 | 08600 | 99630 | 4 | 0 |
| 28 | 57 | 01658 | 99986 | 03403 | 99942 | 05146 | 99867 | 06889 | 99762 | 08629 | 99627 | 3 | 0 |
| 28 | 58 | 01687 | 99986 | 03432 | 99941 | 05175 | 99866 | 06918 | 99760 | 08658 | 99625 | 2 | 0 |
| 29 | 59 | 01716 | 99985 | 03461 | 99940 | 05205 | 99864 | 06947 | 99758 | 08687 | 99622 | 1 | 0 |
| 29 | 60 | 01745 | 99985 | 03490 | 99939 | 05234 | 99863 | 06976 | 99756 | 08716 | 99619 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | 89° | | 88° | | 87° | | 86° | | 85° | | | |

TABLE 41.  [Page 583

### Natural Sines and Cosines.

| Prop. parts 29 | M. | 5° N. sine | N. cos. | 6° N. sine | N. cos. | 7° N. sine | N. cos. | 8° N. sine | N. cos. | 9° N. sine | N. cos. | | Prop. parts 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 08716 | 99619 | 10453 | 99452 | 12187 | 99255 | 13917 | 99027 | 15643 | 98769 | 60 | 4 |
| 0 | 1 | 08745 | 99617 | 10482 | 99449 | 12216 | 99251 | 13946 | 99023 | 15672 | 98764 | 59 | 4 |
| 1 | 2 | 08774 | 99614 | 10511 | 99446 | 12245 | 99248 | 13975 | 99019 | 15701 | 98760 | 58 | 4 |
| 1 | 3 | 08803 | 99612 | 10540 | 99443 | 12274 | 99244 | 14004 | 99015 | 15730 | 98755 | 57 | 4 |
| 2 | 4 | 08831 | 99609 | 10569 | 99440 | 12302 | 99240 | 14033 | 99011 | 15758 | 98751 | 56 | 4 |
| 2 | 5 | 08860 | 99607 | 10597 | 99437 | 12331 | 99237 | 14061 | 99006 | 15787 | 98746 | 55 | 4 |
| 3 | 6 | 08889 | 99604 | 10626 | 99434 | 12360 | 99233 | 14090 | 99002 | 15816 | 98741 | 54 | 4 |
| 3 | 7 | 08918 | 99602 | 10655 | 99431 | 12389 | 99230 | 14119 | 98998 | 15845 | 98737 | 53 | 4 |
| 4 | 8 | 08947 | 99599 | 10684 | 99428 | 12418 | 99226 | 14148 | 98994 | 15873 | 98732 | 52 | 3 |
| 4 | 9 | 08976 | 99596 | 10713 | 99424 | 12447 | 99222 | 14177 | 98990 | 15902 | 98728 | 51 | 3 |
| 5 | 10 | 09005 | 99594 | 10742 | 99421 | 12476 | 99219 | 14205 | 98986 | 15931 | 98723 | 50 | 3 |
| 5 | 11 | 09034 | 99591 | 10771 | 99418 | 12504 | 99215 | 14234 | 98982 | 15959 | 98718 | 49 | 3 |
| 6 | 12 | 09063 | 99588 | 10800 | 99415 | 12533 | 99211 | 14263 | 98978 | 15988 | 98714 | 48 | 3 |
| 6 | 13 | 09092 | 99586 | 10829 | 99412 | 12562 | 99208 | 14292 | 98973 | 16017 | 98709 | 47 | 3 |
| 7 | 14 | 09121 | 99583 | 10858 | 99409 | 12591 | 99204 | 14320 | 98969 | 16046 | 98704 | 46 | 3 |
| 7 | 15 | 09150 | 99580 | 10887 | 99406 | 12620 | 99200 | 14349 | 98965 | 16074 | 98700 | 45 | 3 |
| 8 | 16 | 09179 | 99578 | 10916 | 99402 | 12649 | 99197 | 14378 | 98961 | 16103 | 98695 | 44 | 3 |
| 8 | 17 | 09208 | 99575 | 10945 | 99399 | 12678 | 99193 | 14407 | 98957 | 16132 | 98690 | 43 | 3 |
| 9 | 18 | 09237 | 99572 | 10973 | 99396 | 12706 | 99189 | 14436 | 98953 | 16160 | 98686 | 42 | 3 |
| 9 | 19 | 09266 | 99570 | 11002 | 99393 | 12735 | 99186 | 14464 | 98948 | 16189 | 98681 | 41 | 3 |
| 10 | 20 | 09295 | 99567 | 11031 | 99390 | 12764 | 99182 | 14493 | 98944 | 16218 | 98676 | 40 | 3 |
| 10 | 21 | 09324 | 99564 | 11060 | 99386 | 12793 | 99178 | 14522 | 98940 | 16246 | 98671 | 39 | 3 |
| 11 | 22 | 09353 | 99562 | 11089 | 99383 | 12822 | 99175 | 14551 | 98936 | 16275 | 98667 | 38 | 3 |
| 11 | 23 | 09382 | 99559 | 11118 | 99380 | 12851 | 99171 | 14580 | 98931 | 16304 | 98662 | 37 | 2 |
| 12 | 24 | 09411 | 99556 | 11147 | 99377 | 12880 | 99167 | 14608 | 98927 | 16333 | 98657 | 36 | 2 |
| 12 | 25 | 09440 | 99553 | 11176 | 99374 | 12908 | 99163 | 14637 | 98923 | 16361 | 98652 | 35 | 2 |
| 13 | 26 | 09469 | 99551 | 11205 | 99370 | 12937 | 99160 | 14666 | 98919 | 16390 | 98648 | 34 | 2 |
| 13 | 27 | 09498 | 99548 | 11234 | 99367 | 12966 | 99156 | 14695 | 98914 | 16419 | 98643 | 33 | 2 |
| 14 | 28 | 09527 | 99545 | 11263 | 99364 | 12995 | 99152 | 14723 | 98910 | 16447 | 98638 | 32 | 2 |
| 14 | 29 | 09556 | 99542 | 11291 | 99360 | 13024 | 99148 | 14752 | 98906 | 16476 | 98633 | 31 | 2 |
| 15 | 30 | 09585 | 99540 | 11320 | 99357 | 13053 | 99144 | 14781 | 98902 | 16505 | 98629 | 30 | 2 |
| 15 | 31 | 09614 | 99537 | 11349 | 99354 | 13081 | 99141 | 14810 | 98897 | 16533 | 98624 | 29 | 2 |
| 15 | 32 | 09642 | 99534 | 11378 | 99351 | 13110 | 99137 | 14838 | 98893 | 16562 | 98619 | 28 | 2 |
| 16 | 33 | 09671 | 99531 | 11407 | 99347 | 13139 | 99133 | 14867 | 98889 | 16591 | 98614 | 27 | 2 |
| 16 | 34 | 09700 | 99528 | 11436 | 99344 | 13168 | 99129 | 14896 | 98884 | 16620 | 98609 | 26 | 2 |
| 17 | 35 | 09729 | 99526 | 11465 | 99341 | 13197 | 99125 | 14925 | 98880 | 16648 | 98604 | 25 | 2 |
| 17 | 36 | 09758 | 99523 | 11494 | 99337 | 13226 | 99122 | 14954 | 98876 | 16677 | 98600 | 24 | 2 |
| 18 | 37 | 09787 | 99520 | 11523 | 99334 | 13254 | 99118 | 14982 | 98871 | 16706 | 98595 | 23 | 2 |
| 18 | 38 | 09816 | 99517 | 11552 | 99331 | 13283 | 99114 | 15011 | 98867 | 16734 | 98590 | 22 | 1 |
| 19 | 39 | 09845 | 99514 | 11580 | 99327 | 13312 | 99110 | 15040 | 98863 | 16763 | 98585 | 21 | 1 |
| 19 | 40 | 09874 | 99511 | 11609 | 99324 | 13341 | 99106 | 15069 | 98858 | 16792 | 98580 | 20 | 1 |
| 20 | 41 | 09903 | 99508 | 11638 | 99320 | 13370 | 99102 | 15097 | 98854 | 16820 | 98575 | 19 | 1 |
| 20 | 42 | 09932 | 99506 | 11667 | 99317 | 13399 | 99098 | 15126 | 98849 | 16849 | 98570 | 18 | 1 |
| 21 | 43 | 09961 | 99503 | 11696 | 99314 | 13427 | 99094 | 15155 | 98845 | 16878 | 98565 | 17 | 1 |
| 21 | 44 | 09990 | 99500 | 11725 | 99310 | 13456 | 99091 | 15184 | 98841 | 16906 | 98561 | 16 | 1 |
| 22 | 45 | 10019 | 99497 | 11754 | 99307 | 13485 | 99087 | 15212 | 98836 | 16935 | 98556 | 15 | 1 |
| 22 | 46 | 10048 | 99494 | 11783 | 99303 | 13514 | 99083 | 15241 | 98832 | 16964 | 98551 | 14 | 1 |
| 23 | 47 | 10077 | 99491 | 11812 | 99300 | 13543 | 99079 | 15270 | 98827 | 16992 | 98546 | 13 | 1 |
| 23 | 48 | 10106 | 99488 | 11840 | 99297 | 13572 | 99075 | 15299 | 98823 | 17021 | 98541 | 12 | 1 |
| 24 | 49 | 10135 | 99485 | 11869 | 99293 | 13600 | 99071 | 15327 | 98818 | 17050 | 98536 | 11 | 1 |
| 24 | 50 | 10164 | 99482 | 11898 | 99290 | 13629 | 99067 | 15356 | 98814 | 17078 | 98531 | 10 | 1 |
| 25 | 51 | 10192 | 99479 | 11927 | 99286 | 13658 | 99063 | 15385 | 98809 | 17107 | 98526 | 9 | 1 |
| 25 | 52 | 10221 | 99476 | 11956 | 99283 | 13687 | 99059 | 15414 | 98805 | 17136 | 98521 | 8 | 1 |
| 26 | 53 | 10250 | 99473 | 11985 | 99279 | 13716 | 99055 | 15442 | 98800 | 17164 | 98516 | 7 | 0 |
| 26 | 54 | 10279 | 99470 | 12014 | 99276 | 13744 | 99051 | 15471 | 98796 | 17193 | 98511 | 6 | 0 |
| 27 | 55 | 10308 | 99467 | 12043 | 99272 | 13773 | 99047 | 15500 | 98791 | 17222 | 98506 | 5 | 0 |
| 27 | 56 | 10337 | 99464 | 12071 | 99269 | 13802 | 99043 | 15529 | 98787 | 17250 | 98501 | 4 | 0 |
| 28 | 57 | 10366 | 99461 | 12100 | 99265 | 13831 | 99039 | 15557 | 98782 | 17279 | 98496 | 3 | 0 |
| 28 | 58 | 10395 | 99458 | 12129 | 99262 | 13860 | 99035 | 15586 | 98778 | 17308 | 98491 | 2 | 0 |
| 29 | 59 | 10424 | 99455 | 12158 | 99258 | 13889 | 99031 | 15615 | 98773 | 17336 | 98486 | 1 | 0 |
| 29 | 60 | 10453 | 99452 | 12187 | 99255 | 13917 | 99027 | 15643 | 98769 | 17365 | 98481 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | 84° | | 83° | | 82° | | 81° | | 80° | | | |

# TABLE 41.

### Natural Sines and Cosines.

| Prop. parts 28 | M. | 10° | | 11° | | 12° | | 13° | | 14° | | | Prop. parts 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | | |
| 0 | 0 | 17365 | 98481 | 19081 | 98163 | 20791 | 97815 | 22495 | 97437 | 24192 | 97030 | 60 | 6 |
| 0 | 1 | 17393 | 98476 | 19109 | 98157 | 20820 | 97809 | 22523 | 97430 | 24220 | 97023 | 59 | 6 |
| 1 | 2 | 17422 | 98471 | 19138 | 98152 | 20848 | 97803 | 22552 | 97424 | 24249 | 97015 | 58 | 6 |
| 1 | 3 | 17451 | 98466 | 19167 | 98146 | 20877 | 97797 | 22580 | 97417 | 24277 | 97008 | 57 | 6 |
| 2 | 4 | 17479 | 98461 | 19195 | 98140 | 20905 | 97791 | 22608 | 97411 | 24305 | 97001 | 56 | 6 |
| 2 | 5 | 17508 | 98455 | 19224 | 98135 | 20933 | 97784 | 22637 | 97404 | 24333 | 96994 | 55 | 6 |
| 3 | 6 | 17537 | 98450 | 19252 | 98129 | 20962 | 97778 | 22665 | 97398 | 24362 | 96987 | 54 | 5 |
| 3 | 7 | 17565 | 98445 | 19281 | 98124 | 20990 | 97772 | 22693 | 97391 | 24390 | 96980 | 53 | 5 |
| 4 | 8 | 17594 | 98440 | 19309 | 98118 | 21019 | 97766 | 22722 | 97384 | 24418 | 96973 | 52 | 5 |
| 4 | 9 | 17623 | 98435 | 19338 | 98112 | 21047 | 97760 | 22750 | 97378 | 24446 | 96966 | 51 | 5 |
| 5 | 10 | 17651 | 98430 | 19366 | 98107 | 21076 | 97754 | 22778 | 97371 | 24474 | 96959 | 50 | 5 |
| 5 | 11 | 17680 | 98425 | 19395 | 98101 | 21104 | 97748 | 22807 | 97365 | 24503 | 96952 | 49 | 5 |
| 6 | 12 | 17708 | 98420 | 19423 | 98096 | 21132 | 97742 | 22835 | 97358 | 24531 | 96945 | 48 | 5 |
| 6 | 13 | 17737 | 98414 | 19452 | 98090 | 21161 | 97735 | 22863 | 97351 | 24559 | 96937 | 47 | 5 |
| 7 | 14 | 17766 | 98409 | 19481 | 98084 | 21189 | 97729 | 22892 | 97345 | 24587 | 96930 | 46 | 5 |
| 7 | 15 | 17794 | 98404 | 19509 | 98079 | 21218 | 97723 | 22920 | 97338 | 24615 | 96923 | 45 | 5 |
| 7 | 16 | 17823 | 98399 | 19538 | 98073 | 21246 | 97717 | 22948 | 97331 | 24644 | 96916 | 44 | 4 |
| 8 | 17 | 17852 | 98394 | 19566 | 98067 | 21275 | 97711 | 22977 | 97325 | 24672 | 96909 | 43 | 4 |
| 8 | 18 | 17880 | 98389 | 19595 | 98061 | 21303 | 97705 | 23005 | 97318 | 24700 | 96902 | 42 | 4 |
| 9 | 19 | 17909 | 98383 | 19623 | 98056 | 21331 | 97698 | 23033 | 97311 | 24728 | 96894 | 41 | 4 |
| 9 | 20 | 17937 | 98378 | 19652 | 98050 | 21360 | 97692 | 23062 | 97304 | 24756 | 96887 | 40 | 4 |
| 10 | 21 | 17966 | 98373 | 19680 | 98044 | 21388 | 97686 | 23090 | 97298 | 24784 | 96880 | 39 | 4 |
| 10 | 22 | 17995 | 98368 | 19709 | 98039 | 21417 | 97680 | 23118 | 97291 | 24813 | 96873 | 38 | 4 |
| 11 | 23 | 18023 | 98362 | 19737 | 98033 | 21445 | 97673 | 23146 | 97284 | 24841 | 96866 | 37 | 4 |
| 11 | 24 | 18052 | 98357 | 19766 | 98027 | 21474 | 97667 | 23175 | 97278 | 24869 | 96858 | 36 | 4 |
| 12 | 25 | 18081 | 98352 | 19794 | 98021 | 21502 | 97661 | 23203 | 97271 | 24897 | 96851 | 35 | 4 |
| 12 | 26 | 18109 | 98347 | 19823 | 98016 | 21530 | 97655 | 23231 | 97264 | 24925 | 96844 | 34 | 3 |
| 13 | 27 | 18138 | 98341 | 19851 | 98010 | 21559 | 97648 | 23260 | 97257 | 24954 | 96837 | 33 | 3 |
| 13 | 28 | 18166 | 98336 | 19880 | 98004 | 21587 | 97642 | 23288 | 97251 | 24982 | 96829 | 32 | 3 |
| 14 | 29 | 18195 | 98331 | 19908 | 97998 | 21616 | 97636 | 23316 | 97244 | 25010 | 96822 | 31 | 3 |
| 14 | 30 | 18224 | 98325 | 19937 | 97992 | 21644 | 97630 | 23345 | 97237 | 25038 | 96815 | 30 | 3 |
| 14 | 31 | 18252 | 98320 | 19965 | 97987 | 21672 | 97623 | 23373 | 97230 | 25066 | 96807 | 29 | 3 |
| 15 | 32 | 18281 | 98315 | 19994 | 97981 | 21701 | 97617 | 23401 | 97223 | 25094 | 96800 | 28 | 3 |
| 15 | 33 | 18309 | 98310 | 20022 | 97975 | 21729 | 97611 | 23429 | 97217 | 25122 | 96793 | 27 | 3 |
| 16 | 34 | 18338 | 98304 | 20051 | 97969 | 21758 | 97604 | 23458 | 97210 | 25151 | 96786 | 26 | 3 |
| 16 | 35 | 18367 | 98299 | 20079 | 97963 | 21786 | 97598 | 23486 | 97203 | 25179 | 96778 | 25 | 3 |
| 17 | 36 | 18395 | 98294 | 20108 | 97958 | 21814 | 97592 | 23514 | 97196 | 25207 | 96771 | 24 | 2 |
| 17 | 37 | 18424 | 98288 | 20136 | 97952 | 21843 | 97585 | 23542 | 97189 | 25235 | 96764 | 23 | 2 |
| 18 | 38 | 18452 | 98283 | 20165 | 97946 | 21871 | 97579 | 23571 | 97182 | 25263 | 96756 | 22 | 2 |
| 18 | 39 | 18481 | 98277 | 20193 | 97940 | 21899 | 97573 | 23599 | 97176 | 25291 | 96749 | 21 | 2 |
| 19 | 40 | 18509 | 98272 | 20222 | 97934 | 21928 | 97566 | 23627 | 97169 | 25320 | 96742 | 20 | 2 |
| 19 | 41 | 18538 | 98267 | 20250 | 97928 | 21956 | 97560 | 23656 | 97162 | 25348 | 96734 | 19 | 2 |
| 20 | 42 | 18567 | 98261 | 20279 | 97922 | 21985 | 97553 | 23684 | 97155 | 25376 | 96727 | 18 | 2 |
| 20 | 43 | 18595 | 98256 | 20307 | 97916 | 22013 | 97547 | 23712 | 97148 | 25404 | 96719 | 17 | 2 |
| 21 | 44 | 18624 | 98250 | 20336 | 97910 | 22041 | 97541 | 23740 | 97141 | 25432 | 96712 | 16 | 2 |
| 21 | 45 | 18652 | 98245 | 20364 | 97905 | 22070 | 97534 | 23769 | 97134 | 25460 | 96705 | 15 | 2 |
| 21 | 46 | 18681 | 98240 | 20393 | 97899 | 22098 | 97528 | 23797 | 97127 | 25488 | 96697 | 14 | 1 |
| 22 | 47 | 18710 | 98234 | 20421 | 97893 | 22126 | 97521 | 23825 | 97120 | 25516 | 96690 | 13 | 1 |
| 22 | 48 | 18738 | 98229 | 20450 | 97887 | 22155 | 97515 | 23853 | 97113 | 25545 | 96682 | 12 | 1 |
| 23 | 49 | 18767 | 98223 | 20478 | 97881 | 22183 | 97508 | 23882 | 97106 | 25573 | 96675 | 11 | 1 |
| 23 | 50 | 18795 | 98218 | 20507 | 97875 | 22212 | 97502 | 23910 | 97100 | 25601 | 96667 | 10 | 1 |
| 24 | 51 | 18824 | 98212 | 20535 | 97869 | 22240 | 97496 | 23938 | 97093 | 25629 | 96660 | 9 | 1 |
| 24 | 52 | 18852 | 98207 | 20563 | 97863 | 22268 | 97489 | 23966 | 97086 | 25657 | 96653 | 8 | 1 |
| 25 | 53 | 18881 | 98201 | 20592 | 97857 | 22297 | 97483 | 23995 | 97079 | 25685 | 96645 | 7 | 1 |
| 25 | 54 | 18910 | 98196 | 20620 | 97851 | 22325 | 97476 | 24023 | 97072 | 25713 | 96638 | 6 | 1 |
| 26 | 55 | 18938 | 98190 | 20649 | 97845 | 22353 | 97470 | 24051 | 97065 | 25741 | 96630 | 5 | 1 |
| 26 | 56 | 18967 | 98185 | 20677 | 97839 | 22382 | 97463 | 24079 | 97058 | 25769 | 96623 | 4 | 0 |
| 27 | 57 | 18995 | 98179 | 20706 | 97833 | 22410 | 97457 | 24108 | 97051 | 25798 | 96615 | 3 | 0 |
| 27 | 58 | 19024 | 98174 | 20734 | 97827 | 22438 | 97450 | 24136 | 97044 | 25826 | 96608 | 2 | 0 |
| 28 | 59 | 19052 | 98168 | 20763 | 97821 | 22467 | 97444 | 24164 | 97037 | 25854 | 96600 | 1 | 0 |
| 28 | 60 | 19081 | 98163 | 20791 | 97815 | 22495 | 97437 | 24192 | 97030 | 25882 | 96593 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | 79° | | 78° | | 77° | | 76° | | 75° | | | |

TABLE 41. [Page 585

Natural Sines and Cosines.

| Prop. parts 27 | M. | 15° N. sine. | N. cos. | 16° N. sine. | N. cos. | 17° N. sine. | N. cos. | 18° N. sine. | N. cos. | 19° N. sine. | N. cos. | | Prop. parts 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 25882 | 96593 | 27564 | 96126 | 29237 | 95630 | 30902 | 95106 | 32557 | 94552 | 60 | 9 |
| 0 | 1 | 25910 | 96585 | 27592 | 96118 | 29265 | 95622 | 30929 | 95097 | 32584 | 94542 | 59 | 9 |
| 1 | 2 | 25938 | 96578 | 27620 | 96110 | 29293 | 95613 | 30957 | 95088 | 32612 | 94533 | 58 | 9 |
| 1 | 3 | 25966 | 96570 | 27648 | 96102 | 29321 | 95605 | 30985 | 95079 | 32639 | 94523 | 57 | 9 |
| 2 | 4 | 25994 | 96562 | 27676 | 96094 | 29348 | 95596 | 31012 | 95070 | 32667 | 94514 | 56 | 8 |
| 2 | 5 | 26022 | 96555 | 27704 | 96086 | 29376 | 95588 | 31040 | 95061 | 32694 | 94504 | 55 | 8 |
| 3 | 6 | 26050 | 96547 | 27731 | 96078 | 29404 | 95579 | 31068 | 95052 | 32722 | 94495 | 54 | 8 |
| 3 | 7 | 26079 | 96540 | 27759 | 96070 | 29432 | 95571 | 31095 | 95043 | 32749 | 94485 | 53 | 8 |
| 4 | 8 | 26107 | 96532 | 27787 | 96062 | 29460 | 95562 | 31123 | 95033 | 32777 | 94476 | 52 | 8 |
| 4 | 9 | 26135 | 96524 | 27815 | 96054 | 29487 | 95554 | 31151 | 95024 | 32804 | 94466 | 51 | 8 |
| 5 | 10 | 26163 | 96517 | 27843 | 96046 | 29515 | 95545 | 31178 | 95015 | 32832 | 94457 | 50 | 8 |
| 5 | 11 | 26191 | 96509 | 27871 | 96037 | 29543 | 95536 | 31206 | 95006 | 32859 | 94447 | 49 | 7 |
| 5 | 12 | 26219 | 96502 | 27899 | 96029 | 29571 | 95528 | 31233 | 94997 | 32887 | 94438 | 48 | 7 |
| 6 | 13 | 26247 | 96494 | 27927 | 96021 | 29599 | 95519 | 31261 | 94988 | 32914 | 94428 | 47 | 7 |
| 6 | 14 | 26275 | 96486 | 27955 | 96013 | 29626 | 95511 | 31289 | 94979 | 32942 | 94418 | 46 | 7 |
| 7 | 15 | 26303 | 96479 | 27983 | 96005 | 29654 | 95502 | 31316 | 94970 | 32969 | 94409 | 45 | 7 |
| 7 | 16 | 26331 | 96471 | 28011 | 95997 | 29682 | 95493 | 31344 | 94961 | 32997 | 94399 | 44 | 7 |
| 8 | 17 | 26359 | 96463 | 28039 | 95989 | 29710 | 95485 | 31372 | 94952 | 33024 | 94390 | 43 | 6 |
| 8 | 18 | 26387 | 96456 | 28067 | 95981 | 29737 | 95476 | 31399 | 94943 | 33051 | 94380 | 42 | 6 |
| 9 | 19 | 26415 | 96448 | 28095 | 95972 | 29765 | 95467 | 31427 | 94933 | 33079 | 94370 | 41 | 6 |
| 9 | 20 | 26443 | 96440 | 28123 | 95964 | 29793 | 95459 | 31454 | 94924 | 33106 | 94361 | 40 | 6 |
| 9 | 21 | 26471 | 96433 | 28150 | 95956 | 29821 | 95450 | 31482 | 94915 | 33134 | 94351 | 39 | 6 |
| 10 | 22 | 26500 | 96425 | 28178 | 95948 | 29849 | 95441 | 31510 | 94906 | 33161 | 94342 | 38 | 6 |
| 10 | 23 | 26528 | 96417 | 28206 | 95940 | 29876 | 95433 | 31537 | 94897 | 33189 | 94332 | 37 | 6 |
| 11 | 24 | 26556 | 96410 | 28234 | 95931 | 29904 | 95424 | 31565 | 94888 | 33216 | 94322 | 36 | 5 |
| 11 | 25 | 26584 | 96402 | 28262 | 95923 | 29932 | 95415 | 31593 | 94878 | 33244 | 94313 | 35 | 5 |
| 12 | 26 | 26612 | 96394 | 28290 | 95915 | 29960 | 95407 | 31620 | 94869 | 33271 | 94303 | 34 | 5 |
| 12 | 27 | 26640 | 96386 | 28318 | 95907 | 29987 | 95398 | 31648 | 94860 | 33298 | 94293 | 33 | 5 |
| 13 | 28 | 26668 | 96379 | 28346 | 95898 | 30015 | 95389 | 31675 | 94851 | 33326 | 94284 | 32 | 5 |
| 13 | 29 | 26696 | 96371 | 28374 | 95890 | 30043 | 95380 | 31703 | 94842 | 33353 | 94274 | 31 | 5 |
| 14 | 30 | 26724 | 96363 | 28402 | 95882 | 30071 | 95372 | 31730 | 94832 | 33381 | 94264 | 30 | 5 |
| 14 | 31 | 26752 | 96355 | 28429 | 95874 | 30098 | 95363 | 31758 | 94823 | 33408 | 94254 | 29 | 4 |
| 14 | 32 | 26780 | 96347 | 28457 | 95865 | 30126 | 95354 | 31786 | 94814 | 33436 | 94245 | 28 | 4 |
| 15 | 33 | 26808 | 96340 | 28485 | 95857 | 30154 | 95345 | 31813 | 94805 | 33463 | 94235 | 27 | 4 |
| 15 | 34 | 26836 | 96332 | 28513 | 95849 | 30182 | 95337 | 31841 | 94795 | 33490 | 94225 | 26 | 4 |
| 16 | 35 | 26864 | 96324 | 28541 | 95841 | 30209 | 95328 | 31868 | 94786 | 33518 | 94215 | 25 | 4 |
| 16 | 36 | 26892 | 96316 | 28569 | 95832 | 30237 | 95319 | 31896 | 94777 | 33545 | 94206 | 24 | 4 |
| 17 | 37 | 26920 | 96308 | 28597 | 95824 | 30265 | 95310 | 31923 | 94768 | 33573 | 94196 | 23 | 3 |
| 17 | 38 | 26948 | 96301 | 28625 | 95816 | 30292 | 95301 | 31951 | 94758 | 33600 | 94186 | 22 | 3 |
| 18 | 39 | 26976 | 96293 | 28652 | 95807 | 30320 | 95293 | 31979 | 94749 | 33627 | 94176 | 21 | 3 |
| 18 | 40 | 27004 | 96285 | 28680 | 95799 | 30348 | 95284 | 32006 | 94740 | 33655 | 94167 | 20 | 3 |
| 18 | 41 | 27032 | 96277 | 28708 | 95791 | 30376 | 95275 | 32034 | 94730 | 33682 | 94157 | 19 | 3 |
| 19 | 42 | 27060 | 96269 | 28736 | 95782 | 30403 | 95266 | 32061 | 94721 | 33710 | 94147 | 18 | 3 |
| 19 | 43 | 27088 | 96261 | 28764 | 95774 | 30431 | 95257 | 32089 | 94712 | 33737 | 94137 | 17 | 3 |
| 20 | 44 | 27116 | 96253 | 28792 | 95766 | 30459 | 95248 | 32116 | 94702 | 33764 | 94127 | 16 | 2 |
| 20 | 45 | 27144 | 96246 | 28820 | 95757 | 30486 | 95240 | 32144 | 94693 | 33792 | 94118 | 15 | 2 |
| 21 | 46 | 27172 | 96238 | 28847 | 95749 | 30514 | 95231 | 32171 | 94684 | 33819 | 94108 | 14 | 2 |
| 21 | 47 | 27200 | 96230 | 28875 | 95740 | 30542 | 95222 | 32199 | 94674 | 33846 | 94098 | 13 | 2 |
| 22 | 48 | 27228 | 96222 | 28903 | 95732 | 30570 | 95213 | 32227 | 94665 | 33874 | 94088 | 12 | 2 |
| 22 | 49 | 27256 | 96214 | 28931 | 95724 | 30597 | 95204 | 32254 | 94656 | 33901 | 94078 | 11 | 2 |
| 23 | 50 | 27284 | 96206 | 28959 | 95715 | 30625 | 95195 | 32282 | 94646 | 33929 | 94068 | 10 | 2 |
| 23 | 51 | 27312 | 96198 | 28987 | 95707 | 30653 | 95186 | 32309 | 94637 | 33956 | 94058 | 9 | 1 |
| 23 | 52 | 27340 | 96190 | 29015 | 95698 | 30680 | 95177 | 32337 | 94627 | 33983 | 94049 | 8 | 1 |
| 24 | 53 | 27368 | 96182 | 29042 | 95690 | 30708 | 95168 | 32364 | 94618 | 34011 | 94039 | 7 | 1 |
| 24 | 54 | 27396 | 96174 | 29070 | 95681 | 30736 | 95159 | 32392 | 94609 | 34038 | 94029 | 6 | 1 |
| 25 | 55 | 27424 | 96166 | 29098 | 95673 | 30763 | 95150 | 32419 | 94599 | 34065 | 94019 | 5 | 1 |
| 25 | 56 | 27452 | 96158 | 29126 | 95664 | 30791 | 95142 | 32447 | 94590 | 34093 | 94009 | 4 | 1 |
| 26 | 57 | 27480 | 96150 | 29154 | 95656 | 30819 | 95133 | 32474 | 94580 | 34120 | 93999 | 3 | 0 |
| 26 | 58 | 27508 | 96142 | 29182 | 95647 | 30846 | 95124 | 32502 | 94571 | 34147 | 93989 | 2 | 0 |
| 27 | 59 | 27536 | 96134 | 29209 | 95639 | 30874 | 95115 | 32529 | 94561 | 34175 | 93979 | 1 | 0 |
| 27 | 60 | 27564 | 96126 | 29237 | 95630 | 30902 | 95106 | 32557 | 94552 | 34202 | 93969 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | 74° | | 73° | | 72° | | 71° | | 70° | | | |

# TABLE 41.

### Natural Sines and Cosines.

| Prop. parts 27 | M. | 20° N. sine. | 20° N. cos. | 21° N. sine. | 21° N. cos. | 22° N. sine. | 22° N. cos. | 23° N. sine. | 23° N. cos. | 24° N. sine. | 24° N. cos. | | Prop. parts 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 34202 | 93969 | 35837 | 93358 | 37461 | 92718 | 39073 | 92050 | 40674 | 91355 | 60 | 11 |
| 0 | 1 | 34229 | 93959 | 35864 | 93348 | 37488 | 92707 | 39100 | 92039 | 40700 | 91343 | 59 | 11 |
| 1 | 2 | 34257 | 93949 | 35891 | 93337 | 37515 | 92697 | 39127 | 92028 | 40727 | 91331 | 58 | 11 |
| 1 | 3 | 34284 | 93939 | 35918 | 93327 | 37542 | 92686 | 39153 | 92016 | 40753 | 91319 | 57 | 10 |
| 2 | 4 | 34311 | 93929 | 35945 | 93316 | 37569 | 92675 | 39180 | 92005 | 40780 | 91307 | 56 | 10 |
| 2 | 5 | 34339 | 93919 | 35973 | 93306 | 37595 | 92664 | 39207 | 91994 | 40806 | 91295 | 55 | 10 |
| 3 | 6 | 34366 | 93909 | 36000 | 93295 | 37622 | 92653 | 39234 | 91982 | 40833 | 91283 | 54 | 10 |
| 3 | 7 | 34393 | 93899 | 36027 | 93285 | 37649 | 92642 | 39260 | 91971 | 40860 | 91272 | 53 | 10 |
| 4 | 8 | 34421 | 93889 | 36054 | 93274 | 37676 | 92631 | 39287 | 91959 | 40886 | 91260 | 52 | 10 |
| 4 | 9 | 34448 | 93879 | 36081 | 93264 | 37703 | 92620 | 39314 | 91948 | 40913 | 91248 | 51 | 9 |
| 5 | 10 | 34475 | 93869 | 36108 | 93253 | 37730 | 92609 | 39341 | 91936 | 40939 | 91236 | 50 | 9 |
| 5 | 11 | 34503 | 93859 | 36135 | 93243 | 37757 | 92598 | 39367 | 91925 | 40966 | 91224 | 49 | 9 |
| 5 | 12 | 34530 | 93849 | 36162 | 93232 | 37784 | 92587 | 39394 | 91914 | 40992 | 91212 | 48 | 9 |
| 6 | 13 | 34557 | 93839 | 36190 | 93222 | 37811 | 92576 | 39421 | 91902 | 41019 | 91200 | 47 | 9 |
| 6 | 14 | 34584 | 93829 | 36217 | 93211 | 37838 | 92565 | 39448 | 91891 | 41045 | 91188 | 46 | 8 |
| 7 | 15 | 34612 | 93819 | 36244 | 93201 | 37865 | 92554 | 39474 | 91879 | 41072 | 91176 | 45 | 8 |
| 7 | 16 | 34639 | 93809 | 36271 | 93190 | 37892 | 92543 | 39501 | 91868 | 41098 | 91164 | 44 | 8 |
| 8 | 17 | 34666 | 93799 | 36298 | 93180 | 37919 | 92532 | 39528 | 91856 | 41125 | 91152 | 43 | 8 |
| 8 | 18 | 34694 | 93789 | 36325 | 93169 | 37946 | 92521 | 39555 | 91845 | 41151 | 91140 | 42 | 8 |
| 9 | 19 | 34721 | 93779 | 36352 | 93159 | 37973 | 92510 | 39581 | 91833 | 41178 | 91128 | 41 | 8 |
| 9 | 20 | 34748 | 93769 | 36379 | 93148 | 37999 | 92499 | 39608 | 91822 | 41204 | 91116 | 40 | 7 |
| 9 | 21 | 34775 | 93759 | 36406 | 93137 | 38026 | 92488 | 39635 | 91810 | 41231 | 91104 | 39 | 7 |
| 10 | 22 | 34803 | 93748 | 36434 | 93127 | 38053 | 92477 | 39661 | 91799 | 41257 | 91092 | 38 | 7 |
| 10 | 23 | 34830 | 93738 | 36461 | 93116 | 38080 | 92466 | 39688 | 91787 | 41284 | 91080 | 37 | 7 |
| 11 | 24 | 34857 | 93728 | 36488 | 93106 | 38107 | 92455 | 39715 | 91775 | 41310 | 91068 | 36 | 7 |
| 11 | 25 | 34884 | 93718 | 36515 | 93095 | 38134 | 92444 | 39741 | 91764 | 41337 | 91056 | 35 | 6 |
| 12 | 26 | 34912 | 93708 | 36542 | 93084 | 38161 | 92432 | 39768 | 91752 | 41363 | 91044 | 34 | 6 |
| 12 | 27 | 34939 | 93698 | 36569 | 93074 | 38188 | 92421 | 39795 | 91741 | 41390 | 91032 | 33 | 6 |
| 13 | 28 | 34966 | 93688 | 36596 | 93063 | 38215 | 92410 | 39822 | 91729 | 41416 | 91020 | 32 | 6 |
| 13 | 29 | 34993 | 93677 | 36623 | 93052 | 38241 | 92399 | 39848 | 91718 | 41443 | 91008 | 31 | 6 |
| 14 | 30 | 35021 | 93667 | 36650 | 93042 | 38268 | 92388 | 39875 | 91706 | 41469 | 90996 | 30 | 6 |
| 14 | 31 | 35048 | 93657 | 36677 | 93031 | 38295 | 92377 | 39902 | 91694 | 41496 | 90984 | 29 | 5 |
| 14 | 32 | 35075 | 93647 | 36704 | 93020 | 38322 | 92366 | 39928 | 91683 | 41522 | 90972 | 28 | 5 |
| 15 | 33 | 35102 | 93637 | 36731 | 93010 | 38349 | 92355 | 39955 | 91671 | 41549 | 90960 | 27 | 5 |
| 15 | 34 | 35130 | 93626 | 36758 | 92999 | 38376 | 92343 | 39982 | 91660 | 41575 | 90948 | 26 | 5 |
| 16 | 35 | 35157 | 93616 | 36785 | 92988 | 38403 | 92332 | 40008 | 91648 | 41602 | 90936 | 25 | 5 |
| 16 | 36 | 35184 | 93606 | 36812 | 92978 | 38430 | 92321 | 40035 | 91636 | 41628 | 90924 | 24 | 4 |
| 17 | 37 | 35211 | 93596 | 36839 | 92967 | 38456 | 92310 | 40062 | 91625 | 41655 | 90911 | 23 | 4 |
| 17 | 38 | 35239 | 93585 | 36867 | 92956 | 38483 | 92299 | 40088 | 91613 | 41681 | 90899 | 22 | 4 |
| 18 | 39 | 35266 | 93575 | 36894 | 92945 | 38510 | 92287 | 40115 | 91601 | 41707 | 90887 | 21 | 4 |
| 18 | 40 | 35293 | 93565 | 36921 | 92935 | 38537 | 92276 | 40141 | 91590 | 41734 | 90875 | 20 | 4 |
| 18 | 41 | 35320 | 93555 | 36948 | 92924 | 38564 | 92265 | 40168 | 91578 | 41760 | 90863 | 19 | 3 |
| 19 | 42 | 35347 | 93544 | 36975 | 92913 | 38591 | 92254 | 40195 | 91566 | 41787 | 90851 | 18 | 3 |
| 19 | 43 | 35375 | 93534 | 37002 | 92902 | 38617 | 92243 | 40221 | 91555 | 41813 | 90839 | 17 | 3 |
| 20 | 44 | 35402 | 93524 | 37029 | 92892 | 38644 | 92231 | 40248 | 91543 | 41840 | 90826 | 16 | 3 |
| 20 | 45 | 35429 | 93514 | 37056 | 92881 | 38671 | 92220 | 40275 | 91531 | 41866 | 90814 | 15 | 3 |
| 21 | 46 | 35456 | 93503 | 37083 | 92870 | 38698 | 92209 | 40301 | 91519 | 41892 | 90802 | 14 | 3 |
| 21 | 47 | 35484 | 93493 | 37110 | 92859 | 38725 | 92198 | 40328 | 91508 | 41919 | 90790 | 13 | 2 |
| 22 | 48 | 35511 | 93483 | 37137 | 92849 | 38752 | 92186 | 40355 | 91496 | 41945 | 90778 | 12 | 2 |
| 22 | 49 | 35538 | 93472 | 37164 | 92838 | 38778 | 92175 | 40381 | 91484 | 41972 | 90766 | 11 | 2 |
| 23 | 50 | 35565 | 93462 | 37191 | 92827 | 38805 | 92164 | 40408 | 91472 | 41998 | 90753 | 10 | 2 |
| 23 | 51 | 35592 | 93452 | 37218 | 92816 | 38832 | 92152 | 40434 | 91461 | 42024 | 90741 | 9 | 2 |
| 23 | 52 | 35619 | 93441 | 37245 | 92805 | 38859 | 92141 | 40461 | 91449 | 42051 | 90729 | 8 | 1 |
| 24 | 53 | 35647 | 93431 | 37272 | 92794 | 38886 | 92130 | 40488 | 91437 | 42077 | 90717 | 7 | 1 |
| 24 | 54 | 35674 | 93420 | 37299 | 92784 | 38912 | 92119 | 40514 | 91425 | 42104 | 90704 | 6 | 1 |
| 25 | 55 | 35701 | 93410 | 37326 | 92773 | 38939 | 92107 | 40541 | 91414 | 42130 | 90692 | 5 | 1 |
| 25 | 56 | 35728 | 93400 | 37353 | 92762 | 38966 | 92096 | 40567 | 91402 | 42156 | 90680 | 4 | 1 |
| 26 | 57 | 35755 | 93389 | 37380 | 92751 | 38993 | 92085 | 40594 | 91390 | 42183 | 90668 | 3 | 1 |
| 26 | 58 | 35782 | 93379 | 37407 | 92740 | 39020 | 92073 | 40621 | 91378 | 42209 | 90655 | 2 | 0 |
| 27 | 59 | 35810 | 93368 | 37434 | 92729 | 39046 | 92062 | 40647 | 91366 | 42235 | 90643 | 1 | 0 |
| 27 | 60 | 35837 | 93358 | 37461 | 92718 | 39073 | 92050 | 40674 | 91355 | 42262 | 90631 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | 69° | | 68° | | 67° | | 66° | | 65° | | | |

TABLE 41. [Page 587

Natural Sines and Cosines.

| Prop. parts 26 | M. | 25° | | 26° | | 27° | | 28° | | 29° | | | Prop. parts 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | | |
| 0 | 0 | 42262 | 90631 | 43837 | 89879 | 45399 | 89101 | 46947 | 88295 | 48481 | 87462 | 60 | 14 |
| 0 | 1 | 42288 | 90618 | 43863 | 89867 | 45425 | 89087 | 46973 | 88281 | 48506 | 87448 | 59 | 14 |
| 1 | 2 | 42315 | 90606 | 43889 | 89854 | 45451 | 89074 | 46999 | 88267 | 48532 | 87434 | 58 | 14 |
| 1 | 3 | 42341 | 90594 | 43916 | 89841 | 45477 | 89061 | 47024 | 88254 | 48557 | 87420 | 57 | 13 |
| 2 | 4 | 42367 | 90582 | 43942 | 89828 | 45503 | 89048 | 47050 | 88240 | 48583 | 87406 | 56 | 13 |
| 2 | 5 | 42394 | 90569 | 43968 | 89816 | 45529 | 89035 | 47076 | 88226 | 48608 | 87391 | 55 | 13 |
| 3 | 6 | 42420 | 90557 | 43994 | 89803 | 45554 | 89021 | 47101 | 88213 | 48634 | 87377 | 54 | 13 |
| 3 | 7 | 42446 | 90545 | 44020 | 89790 | 45580 | 89008 | 47127 | 88199 | 48659 | 87363 | 53 | 12 |
| 3 | 8 | 42473 | 90532 | 44046 | 89777 | 45606 | 88995 | 47153 | 88185 | 48684 | 87349 | 52 | 12 |
| 4 | 9 | 42499 | 90520 | 44072 | 89764 | 45632 | 88981 | 47178 | 88172 | 48710 | 87335 | 51 | 12 |
| 4 | 10 | 42525 | 90507 | 44098 | 89752 | 45658 | 88968 | 47204 | 88158 | 48735 | 87321 | 50 | 12 |
| 5 | 11 | 42552 | 90495 | 44124 | 89739 | 45684 | 88955 | 47229 | 88144 | 48761 | 87306 | 49 | 11 |
| 5 | 12 | 42578 | 90483 | 44151 | 89726 | 45710 | 88942 | 47255 | 88130 | 48786 | 87292 | 48 | 11 |
| 6 | 13 | 42604 | 90470 | 44177 | 89713 | 45736 | 88928 | 47281 | 88117 | 48811 | 87278 | 47 | 11 |
| 6 | 14 | 42631 | 90458 | 44203 | 89700 | 45762 | 88915 | 47306 | 88103 | 48837 | 87264 | 46 | 11 |
| 7 | 15 | 42657 | 90446 | 44229 | 89687 | 45787 | 88902 | 47332 | 88089 | 48862 | 87250 | 45 | 11 |
| 7 | 16 | 42683 | 90433 | 44255 | 89674 | 45813 | 88888 | 47358 | 88075 | 48888 | 87235 | 44 | 10 |
| 7 | 17 | 42709 | 90421 | 44281 | 89662 | 45839 | 88875 | 47383 | 88062 | 48913 | 87221 | 43 | 10 |
| 8 | 18 | 42736 | 90408 | 44307 | 89649 | 45865 | 88862 | 47409 | 88048 | 48938 | 87207 | 42 | 10 |
| 8 | 19 | 42762 | 90396 | 44333 | 89636 | 45891 | 88848 | 47434 | 88034 | 48964 | 87193 | 41 | 10 |
| 9 | 20 | 42788 | 90383 | 44359 | 89623 | 45917 | 88835 | 47460 | 88020 | 48989 | 87178 | 40 | 9 |
| 9 | 21 | 42815 | 90371 | 44385 | 89610 | 45942 | 88822 | 47486 | 88006 | 49014 | 87164 | 39 | 9 |
| 10 | 22 | 42841 | 90358 | 44411 | 89597 | 45968 | 88808 | 47511 | 87993 | 49040 | 87150 | 38 | 9 |
| 10 | 23 | 42867 | 90346 | 44437 | 89584 | 45994 | 88795 | 47537 | 87979 | 49065 | 87136 | 37 | 9 |
| 10 | 24 | 42894 | 90334 | 44464 | 89571 | 46020 | 88782 | 47562 | 87965 | 49090 | 87121 | 36 | 8 |
| 11 | 25 | 42920 | 90321 | 44490 | 89558 | 46046 | 88768 | 47588 | 87951 | 49116 | 87107 | 35 | 8 |
| 11 | 26 | 42946 | 90309 | 44516 | 89545 | 46072 | 88755 | 47614 | 87937 | 49141 | 87093 | 34 | 8 |
| 12 | 27 | 42972 | 90296 | 44542 | 89532 | 46097 | 88741 | 47639 | 87923 | 49166 | 87079 | 33 | 8 |
| 12 | 28 | 42999 | 90284 | 44568 | 89519 | 46123 | 88728 | 47665 | 87909 | 49192 | 87064 | 32 | 7 |
| 13 | 29 | 43025 | 90271 | 44594 | 89506 | 46149 | 88715 | 47690 | 87896 | 49217 | 87050 | 31 | 7 |
| 13 | 30 | 43051 | 90259 | 44620 | 89493 | 46175 | 88701 | 47716 | 87882 | 49242 | 87036 | 30 | 7 |
| 13 | 31 | 43077 | 90246 | 44646 | 89480 | 46201 | 88688 | 47741 | 87868 | 49268 | 87021 | 29 | 7 |
| 14 | 32 | 43104 | 90233 | 44672 | 89467 | 46226 | 88674 | 47767 | 87854 | 49293 | 87007 | 28 | 7 |
| 14 | 33 | 43130 | 90221 | 44698 | 89454 | 46252 | 88661 | 47793 | 87840 | 49318 | 86993 | 27 | 6 |
| 15 | 34 | 43156 | 90208 | 44724 | 89441 | 46278 | 88647 | 47818 | 87826 | 49344 | 86978 | 26 | 6 |
| 15 | 35 | 43182 | 90196 | 44750 | 89428 | 46304 | 88634 | 47844 | 87812 | 49369 | 86964 | 25 | 6 |
| 16 | 36 | 43209 | 90183 | 44776 | 89415 | 46330 | 88620 | 47869 | 87798 | 49394 | 86949 | 24 | 6 |
| 16 | 37 | 43235 | 90171 | 44802 | 89402 | 46355 | 88607 | 47895 | 87784 | 49419 | 86935 | 23 | 5 |
| 16 | 38 | 43261 | 90158 | 44828 | 89389 | 46381 | 88593 | 47920 | 87770 | 49445 | 86921 | 22 | 5 |
| 17 | 39 | 43287 | 90146 | 44854 | 89376 | 46407 | 88580 | 47946 | 87756 | 49470 | 86906 | 21 | 5 |
| 17 | 40 | 43313 | 90133 | 44880 | 89363 | 46433 | 88566 | 47971 | 87743 | 49495 | 86892 | 20 | 5 |
| 18 | 41 | 43340 | 90120 | 44906 | 89350 | 46458 | 88553 | 47997 | 87729 | 49521 | 86878 | 19 | 4 |
| 18 | 42 | 43366 | 90108 | 44932 | 89337 | 46484 | 88539 | 48022 | 87715 | 49546 | 86863 | 18 | 4 |
| 19 | 43 | 43392 | 90095 | 44958 | 89324 | 46510 | 88526 | 48048 | 87701 | 49571 | 86849 | 17 | 4 |
| 19 | 44 | 43418 | 90082 | 44984 | 89311 | 46536 | 88512 | 48073 | 87687 | 49596 | 86834 | 16 | 4 |
| 20 | 45 | 43445 | 90070 | 45010 | 89298 | 46561 | 88499 | 48099 | 87673 | 49622 | 86820 | 15 | 4 |
| 20 | 46 | 43471 | 90057 | 45036 | 89285 | 46587 | 88485 | 48124 | 87659 | 49647 | 86805 | 14 | 3 |
| 20 | 47 | 43497 | 90045 | 45062 | 89272 | 46613 | 88472 | 48150 | 87645 | 49672 | 86791 | 13 | 3 |
| 21 | 48 | 43523 | 90032 | 45088 | 89259 | 46639 | 88458 | 48175 | 87631 | 49697 | 86777 | 12 | 3 |
| 21 | 49 | 43549 | 90019 | 45114 | 89245 | 46664 | 88445 | 48201 | 87617 | 49723 | 86762 | 11 | 3 |
| 22 | 50 | 43575 | 90007 | 45140 | 89232 | 46690 | 88431 | 48226 | 87603 | 49748 | 86748 | 10 | 2 |
| 22 | 51 | 43602 | 89994 | 45166 | 89219 | 46716 | 88417 | 48252 | 87589 | 49773 | 86733 | 9 | 2 |
| 23 | 52 | 43628 | 89981 | 45192 | 89206 | 46742 | 88404 | 48277 | 87575 | 49798 | 86719 | 8 | 2 |
| 23 | 53 | 43654 | 89968 | 45218 | 89193 | 46767 | 88390 | 48303 | 87561 | 49824 | 86704 | 7 | 2 |
| 23 | 54 | 43680 | 89956 | 45243 | 89180 | 46793 | 88377 | 48328 | 87546 | 49849 | 86690 | 6 | 1 |
| 24 | 55 | 43706 | 89943 | 45269 | 89167 | 46819 | 88363 | 48354 | 87532 | 49874 | 86675 | 5 | 1 |
| 24 | 56 | 43733 | 89930 | 45295 | 89153 | 46844 | 88349 | 48379 | 87518 | 49899 | 86661 | 4 | 1 |
| 25 | 57 | 43759 | 89918 | 45321 | 89140 | 46870 | 88336 | 48405 | 87504 | 49924 | 86646 | 3 | 1 |
| 25 | 58 | 43785 | 89905 | 45347 | 89127 | 46896 | 88322 | 48430 | 87490 | 49950 | 86632 | 2 | 0 |
| 26 | 59 | 43811 | 89892 | 45373 | 89114 | 46921 | 88308 | 48456 | 87476 | 49975 | 86617 | 1 | 0 |
| 26 | 60 | 43837 | 89879 | 45399 | 89101 | 46947 | 88295 | 48481 | 87462 | 50000 | 86603 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | 64° | | 63° | | 62° | | 61° | | 60° | | | |

# TABLE 41.

## Natural Sines and Cosines.

| Prop. parts. 25 | M. | 30° N. sine | 30° N. cos. | 31° N. sine | 31° N. cos. | 32° N. sine | 32° N. cos. | 33° N. sine | 33° N. cos. | 34° N. sine | 34° N. cos. | | Prop. parts. 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 50000 | 86603 | 51504 | 85717 | 52992 | 84805 | 54464 | 83867 | 55919 | 82904 | 60 | 16 |
| 0 | 1 | 50025 | 86588 | 51529 | 85702 | 53017 | 84789 | 54488 | 83851 | 55943 | 82887 | 59 | 16 |
| 1 | 2 | 50050 | 86573 | 51554 | 85687 | 53041 | 84774 | 54513 | 83835 | 55968 | 82871 | 58 | 15 |
| 1 | 3 | 50076 | 86559 | 51579 | 85672 | 53066 | 84759 | 54537 | 83819 | 55992 | 82855 | 57 | 15 |
| 2 | 4 | 50101 | 86544 | 51604 | 85657 | 53091 | 84743 | 54561 | 83804 | 56016 | 82839 | 56 | 15 |
| 2 | 5 | 50126 | 86530 | 51628 | 85642 | 53115 | 84728 | 54586 | 83788 | 56040 | 82822 | 55 | 15 |
| 3 | 6 | 50151 | 86515 | 51653 | 85627 | 53140 | 84712 | 54610 | 83772 | 56064 | 82806 | 54 | 14 |
| 3 | 7 | 50176 | 86501 | 51678 | 85612 | 53164 | 84697 | 54635 | 83756 | 56088 | 82790 | 53 | 14 |
| 3 | 8 | 50201 | 86486 | 51703 | 85597 | 53189 | 84681 | 54659 | 83740 | 56112 | 82773 | 52 | 14 |
| 4 | 9 | 50227 | 86471 | 51728 | 85582 | 53214 | 84666 | 54683 | 83724 | 56136 | 82757 | 51 | 14 |
| 4 | 10 | 50252 | 86457 | 51753 | 85567 | 53238 | 84650 | 54708 | 83708 | 56160 | 82741 | 50 | 13 |
| 5 | 11 | 50277 | 86442 | 51778 | 85551 | 53263 | 84635 | 54732 | 83692 | 56184 | 82724 | 49 | 13 |
| 5 | 12 | 50302 | 86427 | 51803 | 85536 | 53288 | 84619 | 54756 | 83676 | 56208 | 82708 | 48 | 13 |
| 5 | 13 | 50327 | 86413 | 51828 | 85521 | 53312 | 84604 | 54781 | 83660 | 56232 | 82692 | 47 | 13 |
| 6 | 14 | 50352 | 86398 | 51852 | 85506 | 53337 | 84588 | 54805 | 83645 | 56256 | 82675 | 46 | 12 |
| 6 | 15 | 50377 | 86384 | 51877 | 85491 | 53361 | 84573 | 54829 | 83629 | 56280 | 82659 | 45 | 12 |
| 7 | 16 | 50403 | 86369 | 51902 | 85476 | 53386 | 84557 | 54854 | 83613 | 56305 | 82643 | 44 | 12 |
| 7 | 17 | 50428 | 86354 | 51927 | 85461 | 53411 | 84542 | 54878 | 83597 | 56329 | 82626 | 43 | 11 |
| 8 | 18 | 50453 | 86340 | 51952 | 85446 | 53435 | 84526 | 54902 | 83581 | 56353 | 82610 | 42 | 11 |
| 8 | 19 | 50478 | 86325 | 51977 | 85431 | 53460 | 84511 | 54927 | 83565 | 56377 | 82593 | 41 | 11 |
| 8 | 20 | 50503 | 86310 | 52002 | 85416 | 53484 | 84495 | 54951 | 83549 | 56401 | 82577 | 40 | 11 |
| 9 | 21 | 50528 | 86295 | 52026 | 85401 | 53509 | 84480 | 54975 | 83533 | 56425 | 82561 | 39 | 10 |
| 9 | 22 | 50553 | 86281 | 52051 | 85385 | 53534 | 84464 | 54999 | 83517 | 56449 | 82544 | 38 | 10 |
| 10 | 23 | 50578 | 86266 | 52076 | 85370 | 53558 | 84448 | 55024 | 83501 | 56473 | 82528 | 37 | 10 |
| 10 | 24 | 50603 | 86251 | 52101 | 85355 | 53583 | 84433 | 55048 | 83485 | 56497 | 82511 | 36 | 10 |
| 10 | 25 | 50628 | 86237 | 52126 | 85340 | 53607 | 84417 | 55072 | 83469 | 56521 | 82495 | 35 | 9 |
| 11 | 26 | 50654 | 86222 | 52151 | 85325 | 53632 | 84402 | 55097 | 83453 | 56545 | 82478 | 34 | 9 |
| 11 | 27 | 50679 | 86207 | 52175 | 85310 | 53656· | 84386 | 55121 | 83437 | 56569 | 82462 | 33 | 9 |
| 12 | 28 | 50704 | 86192 | 52200 | 85294 | 53681 | 84370 | 55145 | 83421 | 56593 | 82446 | 32 | 9 |
| 12 | 29 | 50729 | 86178 | 52225 | 85279 | 53705 | 84355 | 55169 | 83405 | 56617 | 82429 | 31 | 8 |
| 13 | 30 | 50754 | 86163 | 52250 | 85264 | 53730 | 84339 | 55194 | 83389 | 56641 | 82413 | 30 | 8 |
| 13 | 31 | 50779 | 86148 | 52275 | 85249 | 53754 | 84324 | 55218 | 83373 | 56665 | 82396 | 29 | 8 |
| 13 | 32 | 50804 | 86133 | 52299 | 85234 | 53779 | 84308 | 55242 | 83356 | 56689 | 82380 | 28 | 7 |
| 14 | 33 | 50829 | 86119 | 52324 | 85218 | 53804 | 84292 | 55266 | 83340 | 56713 | 82363 | 27 | 7 |
| 14 | 34 | 50854 | 86104 | 52349 | 85203 | 53828 | 84277 | 55291 | 83324 | 56736 | 82347 | 26 | 7 |
| 15 | 35 | 50879 | 86089 | 52374 | 85188 | 53853 | 84261 | 55315 | 83308 | 56760 | 82330 | 25 | 7 |
| 15 | 36 | 50904 | 86074 | 52399 | 85173 | 53877 | 84245 | 55339 | 83292 | 56784 | 82314 | 24 | 6 |
| 15 | 37 | 50929 | 86059 | 52423 | 85157 | 53902 | 84230 | 55363 | 83276 | 56808 | 82297 | 23 | 6 |
| 16 | 38 | 50954 | 86045 | 52448 | 85142 | 53926 | 84214 | 55388 | 83260 | 56832 | 82281 | 22 | 6 |
| 16 | 39 | 50979 | 86030 | 52473 | 85127 | 53951 | 84198 | 55412 | 83244 | 56856 | 82264 | 21 | 6 |
| 17 | 40 | 51004 | 86015 | 52498 | 85112 | 53975 | 84182 | 55436 | 83228 | 56880 | 82248 | 20 | 5 |
| 17 | 41 | 51029 | 86000 | 52522 | 85096 | 54000 | 84167 | 55460 | 83212 | 56904 | 82231 | 19 | 5 |
| 18 | 42 | 51054 | 85985 | 52547 | 85081 | 54024 | 84151 | 55484 | 83195 | 56928 | 82214 | 18 | 5 |
| 18 | 43 | 51079 | 85970 | 52572 | 85066 | 54049 | 84135 | 55509 | 83179 | 56952 | 82198 | 17 | 5 |
| 18 | 44 | 51104 | 85956 | 52597 | 85051 | 54073 | 84120 | 55533 | 83163 | 56976 | 82181 | 16 | 4 |
| 19 | 45 | 51129 | 85941 | 52621 | 85035 | 54097 | 84104 | 55557 | 83147 | 57000 | 82165 | 15 | 4 |
| 19 | 46 | 51154 | 85926 | 52646 | 85020 | 54122 | 84088 | 55581 | 83131 | 57024 | 82148 | 14 | 4 |
| 20 | 47 | 51179 | 85911 | 52671 | 85005 | 54146 | 84072 | 55605 | 83115 | 57047 | 82132 | 13 | 3 |
| 20 | 48 | 51204 | 85896 | 52696 | 84989 | 54171 | 84057 | 55630 | 83098 | 57071 | 82115 | 12 | 3 |
| 20 | 49 | 51229 | 85881 | 52720 | 84974 | 54195 | 84041 | 55654 | 83082 | 57095 | 82098 | 11 | 3 |
| 21 | 50 | 51254 | 85866 | 52745 | 84959 | 54220 | 84025 | 55678 | 83066 | 57119 | 82082 | 10 | 3 |
| 21 | 51 | 51279 | 85851 | 52770 | 84943 | 54244 | 84009 | 55702 | 83050 | 57143 | 82065 | 9 | 2 |
| 22 | 52 | 51304 | 85836 | 52794 | 84928 | 54260 | 83994 | 55726 | 83034 | 57167 | 82048 | 8 | 2 |
| 22 | 53 | 51329 | 85821 | 52819 | 84913 | 54293 | 83978 | 55750 | 83017 | 57191 | 82032 | 7 | 2 |
| 23 | 54 | 51354 | 85806 | 52844 | 84897 | 54317 | 83962 | 55775 | 83001 | 57215 | 82015 | 6 | 2 |
| 23 | 55 | 51379 | 85792 | 52869 | 84882 | 54342 | 83946 | 55799 | 82985 | 57238 | 81999 | 5 | 1 |
| 23 | 56 | 51404 | 85777 | 52893 | 84866 | 54366 | 83930 | 55823 | 82969 | 57262 | 81982 | 4 | 1 |
| 24 | 57 | 51429 | 85762 | 52918 | 84851 | 54391 | 83915 | 55847 | 82953 | 57286 | 81965 | 3 | 1 |
| 24 | 58 | 51454 | 85747 | 52943 | 84836 | 54415 | 83899 | 55871 | 82936 | 57310 | 81949 | 2 | 1 |
| 25 | 59 | 51479 | 85732 | 52967 | 84820 | 54440 | 83883 | 55895 | 82920 | 57334 | 81932 | 1 | 0 |
| 25 | 60 | 51504 | 85717 | 52992 | 84805 | 54464 | 83867 | 55919 | 82904 | 57358 | 81915 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | | 59° | | 58° | | 57° | | 56° | | 55° | | |

TABLE 41. [Page 589

Natural Sines and Cosines.

| Prop. parts 23 | M. | 35° | | 36° | | 37° | | 38° | | 39° | | | Prop. parts 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | | |
| 0 | 0 | 57358 | 81915 | 58779 | 80902 | 60182 | 79864 | 61566 | 78801 | 62932 | 77715 | 60 | 18 |
| 0 | 1 | 57381 | 81899 | 58802 | 80885 | 60205 | 79846 | 61589 | 78783 | 62955 | 77696 | 59 | 18 |
| 1 | 2 | 57405 | 81882 | 58826 | 80867 | 60228 | 79829 | 61612 | 78765 | 62977 | 77678 | 58 | 17 |
| 1 | 3 | 57429 | 81865 | 58849 | 80850 | 60251 | 79811 | 61635 | 78747 | 63000 | 77660 | 57 | 17 |
| 2 | 4 | 57453 | 81848 | 58873 | 80833 | 60274 | 79793 | 61658 | 78729 | 63022 | 77641 | 56 | 17 |
| 2 | 5 | 57477 | 81832 | 58896 | 80816 | 60298 | 79776 | 61681 | 78711 | 63045 | 77623 | 55 | 17 |
| 2 | 6 | 57501 | 81815 | 58920 | 80799 | 60321 | 79758 | 61704 | 78694 | 63068 | 77605 | 54 | 16 |
| 3 | 7 | 57524 | 81798 | 58943 | 80782 | 60344 | 79741 | 61726 | 78676 | 63090 | 77586 | 53 | 16 |
| 3 | 8 | 57548 | 81782 | 58967 | 80765 | 60367 | 79723 | 61749 | 78658 | 63113 | 77568 | 52 | 16 |
| 3 | 9 | 57572 | 81765 | 58990 | 80748 | 60390 | 79706 | 61772 | 78640 | 63135 | 77550 | 51 | 15 |
| 4 | 10 | 57596 | 81748 | 59014 | 80730 | 60414 | 79688 | 61795 | 78622 | 63158 | 77531 | 50 | 15 |
| 4 | 11 | 57619 | 81731 | 59037 | 80713 | 60437 | 79671 | 61818 | 78604 | 63180 | 77513 | 49 | 15 |
| 5 | 12 | 57643 | 81714 | 59061 | 80696 | 60460 | 79653 | 61841 | 78586 | 63203 | 77494 | 48 | 14 |
| 5 | 13 | 57667 | 81698 | 59084 | 80679 | 60483 | 79635 | 61864 | 78568 | 63225 | 77476 | 47 | 14 |
| 5 | 14 | 57691 | 81681 | 59108 | 80662 | 60506 | 79618 | 61887 | 78550 | 63248 | 77458 | 46 | 14 |
| 6 | 15 | 57715 | 81664 | 59131 | 80644 | 60529 | 79600 | 61909 | 78532 | 63271 | 77439 | 45 | 14 |
| 6 | 16 | 57738 | 81647 | 59154 | 80627 | 60553 | 79583 | 61932 | 78514 | 63293 | 77421 | 44 | 13 |
| 7 | 17 | 57762 | 81631 | 59178 | 80610 | 60576 | 79565 | 61955 | 78496 | 63316 | 77402 | 43 | 13 |
| 7 | 18 | 57786 | 81614 | 59201 | 80593 | 60599 | 79547 | 61978 | 78478 | 63338 | 77384 | 42 | 13 |
| 7 | 19 | 57810 | 81597 | 59225 | 80576 | 60622 | 79530 | 62001 | 78460 | 63361 | 77366 | 41 | 12 |
| 8 | 20 | 57833 | 81580 | 59248 | 80558 | 60645 | 79512 | 62024 | 78442 | 63383 | 77347 | 40 | 12 |
| 8 | 21 | 57857 | 81563 | 59272 | 80541 | 60668 | 79494 | 62046 | 78424 | 63406 | 77329 | 39 | 12 |
| 8 | 22 | 57881 | 81546 | 59295 | 80524 | 60691 | 79477 | 62069 | 78405 | 63428 | 77310 | 38 | 11 |
| 9 | 23 | 57904 | 81530 | 59318 | 80507 | 60714 | 79459 | 62092 | 78387 | 63451 | 77292 | 37 | 11 |
| 9 | 24 | 57928 | 81513 | 59342 | 80489 | 60738 | 79441 | 62115 | 78369 | 63473 | 77273 | 36 | 11 |
| 10 | 25 | 57952 | 81496 | 59365 | 80472 | 60761 | 79424 | 62138 | 78351 | 63496 | 77255 | 35 | 11 |
| 10 | 26 | 57976 | 81479 | 59389 | 80455 | 60784 | 79406 | 62160 | 78333 | 63518 | 77236 | 34 | 10 |
| 10 | 27 | 57999 | 81462 | 59412 | 80438 | 60807 | 79388 | 62183 | 78315 | 63540 | 77218 | 33 | 10 |
| 11 | 28 | 58023 | 81445 | 59436 | 80420 | 60830 | 79371 | 62206 | 78297 | 63563 | 77199 | 32 | 10 |
| 11 | 29 | 58047 | 81428 | 59459 | 80403 | 60853 | 79353 | 62229 | 78279 | 63585 | 77181 | 31 | 9 |
| 12 | 30 | 58070 | 81412 | 59482 | 80386 | 60876 | 79335 | 62251 | 78261 | 63608 | 77162 | 30 | 9 |
| 12 | 31 | 58094 | 81395 | 59506 | 80368 | 60899 | 79318 | 62274 | 78243 | 63630 | 77144 | 29 | 9 |
| 12 | 32 | 58118 | 81378 | 59529 | 80351 | 60922 | 79300 | 62297 | 78225 | 63653 | 77125 | 28 | 8 |
| 13 | 33 | 58141 | 81361 | 59552 | 80334 | 60945 | 79282 | 62320 | 78206 | 63675 | 77107 | 27 | 8 |
| 13 | 34 | 58165 | 81344 | 59576 | 80316 | 60968 | 79264 | 62342 | 78188 | 63698 | 77088 | 26 | 8 |
| 13 | 35 | 58189 | 81327 | 59599 | 80299 | 60991 | 79247 | 62365 | 78170 | 63720 | 77070 | 25 | 8 |
| 14 | 36 | 58212 | 81310 | 59622 | 80282 | 61015 | 79229 | 62388 | 78152 | 63742 | 77051 | 24 | 7 |
| 14 | 37 | 58236 | 81293 | 59646 | 80264 | 61038 | 79211 | 62411 | 78134 | 63765 | 77033 | 23 | 7 |
| 15 | 38 | 58260 | 81276 | 59669 | 80247 | 61061 | 79193 | 62433 | 78116 | 63787 | 77014 | 22 | 7 |
| 15 | 39 | 58283 | 81259 | 59693 | 80230 | 61084 | 79176 | 62456 | 78098 | 63810 | 76996 | 21 | 6 |
| 15 | 40 | 58307 | 81242 | 59716 | 80212 | 61107 | 79158 | 62479 | 78079 | 63832 | 76977 | 20 | 6 |
| 16 | 41 | 58330 | 81225 | 59739 | 80195 | 61130 | 79140 | 62502 | 78061 | 63854 | 76959 | 19 | 6 |
| 16 | 42 | 58354 | 81208 | 59763 | 80178 | 61153 | 79122 | 62524 | 78043 | 63877 | 76940 | 18 | 5 |
| 16 | 43 | 58378 | 81191 | 59786 | 80160 | 61176 | 79105 | 62547 | 78025 | 63899 | 76921 | 17 | 5 |
| 17 | 44 | 58401 | 81174 | 59809 | 80143 | 61199 | 79087 | 62570 | 78007 | 63922 | 76903 | 16 | 5 |
| 17 | 45 | 58425 | 81157 | 59832 | 80125 | 61222 | 79069 | 62592 | 77988 | 63944 | 76884 | 15 | 5 |
| 18 | 46 | 58449 | 81140 | 59856 | 80108 | 61245 | 79051 | 62615 | 77970 | 63966 | 76866 | 14 | 4 |
| 18 | 47 | 58472 | -81123 | 59879 | 80091 | 61268 | 79033 | 62638 | 77952 | 63989 | 76847 | 13 | 4 |
| 18 | 48 | 58496 | 81106 | 59902 | 80073 | 61291 | 79016 | 62660 | 77934 | 64011 | 76828 | 12 | 4 |
| 19 | 49 | 58519 | 81089 | 59926 | 80056 | 61314 | 78998 | 62683 | 77916 | 64033 | 76810 | 11 | 3 |
| 19 | 50 | 58543 | 81072 | 59949 | 80038 | 61337 | 78980 | 62706 | 77897 | 64056 | 76791 | 10 | 3 |
| 20 | 51 | 58567 | 81055 | 59972 | 80021 | 61360 | 78962 | 62728 | 77879 | 64078 | 76772 | 9 | 3 |
| 20 | 52 | 58590 | 81038 | 59995 | 80003 | 61383 | 78944 | 62751 | 77861 | 64100 | 76754 | 8 | 2 |
| 20 | 53 | 58614 | 81021 | 60019 | 79986 | 61406 | 78926 | 62774 | 77843 | 64123 | 76735 | 7 | 2 |
| 21 | 54 | 58637 | 81004 | 60042 | 79968 | 61429 | 78908 | 62796 | 77824 | 64145 | 76717 | 6 | 2 |
| 21 | 55 | 58661 | 80987 | 60065 | 79951 | 61451 | 78891 | 62819 | 77806 | 64167 | 76698 | 5 | 2 |
| 21 | 56 | 58684 | 80970 | 60089 | 79934 | 61474 | 78873 | 62842 | 77788 | 64190 | 76679 | 4 | 1 |
| 22 | 57 | 58708 | 80953 | 60112 | 79916 | 61497 | 78855 | 62864 | 77769 | 64212 | 76661 | 3 | 1 |
| 22 | 58 | 58731 | 80936 | 60135 | 79899 | 61520 | 78837 | 62887 | 77751 | 64234 | 76642 | 2 | 1 |
| 23 | 59 | 58755 | 80919 | 60158 | 79881 | 61543 | 78819 | 62909 | 77733 | 64256 | 76623 | 1 | 0 |
| 23 | 60 | 58779 | 80902 | 60182 | 79864 | 61566 | 78801 | 62932 | 77715 | 64279 | 76604 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | M. | |
| | | 54° | | 53° | | 52° | | 51° | | 50° | | | |

# TABLE 41.

### Natural Sines and Cosines.

| Prop. parts 22 | M. | 40° N. sine | N. cos. | 41° N. sine | N. cos. | 42° N. sine | N. cos. | 43° N. sine | N. cos. | 44° N. sine | N. cos. | | Prop. parts 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 64279 | 76604 | 65606 | 75471 | 66913 | 74314 | 68200 | 73135 | 69466 | 71934 | 60 | 19 |
| 0 | 1 | 64301 | 76586 | 65628 | 75452 | 66935 | 74295 | 68221 | 73116 | 69487 | 71914 | 59 | 19 |
| 1 | 2 | 64323 | 76567 | 65650 | 75433 | 66956 | 74276 | 68242 | 73096 | 69508 | 71894 | 58 | 18 |
| 1 | 3 | 64346 | 76548 | 65672 | 75414 | 66978 | 74256 | 68264 | 73076 | 69529 | 71873 | 57 | 18 |
| 1 | 4 | 64368 | 76530 | 65694 | 75395 | 66999 | 74237 | 68285 | 73056 | 69549 | 71853 | 56 | 18 |
| 2 | 5 | 64390 | 76511 | 65716 | 75375 | 67021 | 74217 | 68306 | 73036 | 69570 | 71833 | 55 | 17 |
| 2 | 6 | 64412 | 76492 | 65738 | 75356 | 67043 | 74198 | 68327 | 73016 | 69591 | 71813 | 54 | 17 |
| 3 | 7 | 64435 | 76473 | 65759 | 75337 | 67064 | 74178 | 68349 | 72996 | 69612 | 71792 | 53 | 17 |
| 3 | 8 | 64457 | 76455 | 65781 | 75318 | 67086 | 74159 | 68370 | 72976 | 69633 | 71772 | 52 | 16 |
| 3 | 9 | 64479 | 76436 | 65803 | 75299 | 67107 | 74139 | 68391 | 72957 | 69654 | 71752 | 51 | 16 |
| 4 | 10 | 64501 | 76417 | 65825 | 75280 | 67129 | 74120 | 68412 | 72937 | 69675 | 71732 | 50 | 16 |
| 4 | 11 | 64524 | 76398 | 65847 | 75261 | 67151 | 74100 | 68434 | 72917 | 69696 | 71711 | 49 | 16 |
| 4 | 12 | 64546 | 76380 | 65869 | 75241 | 67172 | 74080 | 68455 | 72897 | 69717 | 71691 | 48 | 15 |
| 5 | 13 | 64568 | 76361 | 65891 | 75222 | 67194 | 74061 | 68476 | 72877 | 69737 | 71671 | 47 | 15 |
| 5 | 14 | 64590 | 76342 | 65913 | 75203 | 67215 | 74041 | 68497 | 72857 | 69758 | 71650 | 46 | 15 |
| 6 | 15 | 64612 | 76323 | 65935 | 75184 | 67237 | 74022 | 68518 | 72837 | 69779 | 71630 | 45 | 14 |
| 6 | 16 | 64635 | 76304 | 65956 | 75165 | 67258 | 74002 | 68539 | 72817 | 69800 | 71610 | 44 | 14 |
| 6 | 17 | 64657 | 76286 | 65978 | 75146 | 67280 | 73983 | 68561 | 72797 | 69821 | 71590 | 43 | 14 |
| 7 | 18 | 64679 | 76267 | 66000 | 75126 | 67301 | 73963 | 68582 | 72777 | 69842 | 71569 | 42 | 13 |
| 7 | 19 | 64701 | 76248 | 66022 | 75107 | 67323 | 73944 | 68603 | 72757 | 69862 | 71549 | 41 | 13 |
| 7 | 20 | 64723 | 76229 | 66044 | 75088 | 67344 | 73924 | 68624 | 72737 | 69883 | 71529 | 40 | 13 |
| 8 | 21 | 64746 | 76210 | 66066 | 75069 | 67366 | 73904 | 68645 | 72717 | 69904 | 71508 | 39 | 12 |
| 8 | 22 | 64768 | 76192 | 66088 | 75050 | 67387 | 73885 | 68666 | 72697 | 69925 | 71488 | 38 | 12 |
| 8 | 23 | 64790 | 76173 | 66109 | 75030 | 67409 | 73865 | 68688 | 72677 | 69946 | 71468 | 37 | 12 |
| 9 | 24 | 64812 | 76154 | 66131 | 75011 | 67430 | 73846 | 68709 | 72657 | 69966 | 71447 | 36 | 11 |
| 9 | 25 | 64834 | 76135 | 66153 | 74992 | 67452 | 73826 | 68730 | 72637 | 69987 | 71427 | 35 | 11 |
| 10 | 26 | 64856 | 76116 | 66175 | 74973 | 67473 | 73806 | 68751 | 72617 | 70008 | 71407 | 34 | 11· |
| 10 | 27 | 64878 | 76097 | 66197 | 74953 | 67495 | 73787 | 68772 | 72597 | 70029 | 71386 | 33 | 10 |
| 10 | 28 | 64901 | 76078 | 66218 | 74934 | 67516 | 73767 | 68793 | 72577 | 70049 | 71366 | 32 | 10 |
| 11 | 29 | 64923 | 76059 | 66240 | 74915 | 67538 | 73747 | 68814 | 72557 | 70070 | 71345 | 31 | 10 |
| 11 | 30 | 64945 | 76041 | 66262 | 74896 | 67559 | 73728 | 68835 | 72537 | 70091 | 71325 | 30 | 10 |
| 11 | 31 | 64967 | 76022 | 66284 | 74876 | 67580 | 73708 | 68857 | 72517 | 70112 | 71305 | 29 | 9 |
| 12 | 32 | 64989 | 76003 | 66306 | 74857 | 67602 | 73688 | 68878 | 72497 | 70132 | 71284 | 28 | 9 |
| 12 | 33 | 65011 | 75984 | 66327 | 74838 | 67623 | 73669 | 68899 | 72477 | 70153 | 71264 | 27 | 9 |
| 12 | 34 | 65033 | 75965 | 66349 | 74818 | 67645 | 73649 | 68920 | 72457 | 70174 | 71243 | 26 | 8 |
| 13 | 35 | 65055 | 75946 | 66371 | 74799 | 67666 | 73629 | 68941 | 72437 | 70195 | 71223 | 25 | 8 |
| 13 | 36 | 65077 | 75927 | 66393 | 74780 | 67688 | 73610 | 68962 | 72417 | 70215 | 71203 | 24 | 8 |
| 14 | 37 | 65100 | 75908 | 66414 | 74760 | 67709 | 73590 | 68983 | 72397 | 70236 | 71182 | 23 | 7 |
| 14 | 38 | 65122 | 75889 | 66436 | 74741 | 67730 | 73570 | 69004 | 72377 | 70257 | 71162 | 22 | 7 |
| 14 | 39 | 65144 | 75870 | 66458 | 74722 | 67752 | 73551 | 69025 | 72357 | 70277 | 71141 | 21 | 7 |
| 15 | 40 | 65166 | 75851 | 66480 | 74703 | 67773 | 73531 | 69046 | 72337 | 70298 | 71121 | 20 | 6 |
| 15 | 41 | 65188 | 75832 | 66501 | 74683 | 67795 | 73511 | 69067 | 72317 | 70319 | 71100 | 19 | 6 |
| 15 | 42 | 65210 | 75813 | 66523 | 74664 | 67816 | 73491 | 69088 | 72297 | 70339 | 71080 | 18 | 6 |
| 16 | 43 | 65232 | 75794 | 66545 | 74644 | 67837 | 73472 | 69109 | 72277 | 70360 | 71059 | 17 | 5 |
| 16 | 44 | 65254 | 75775 | 66566 | 74625 | 67859 | 73452 | 69130 | 72257 | 70381 | 71039 | 16 | 5 |
| 17 | 45 | 65276 | 75756 | 66588 | 74606 | 67880 | 73432 | 69151 | 72236 | 70401 | 71019 | 15 | 5 |
| 17 | 46 | 65298 | 75738 | 66610 | 74586 | 67901 | 73413 | 69172 | 72216 | 70422 | 70998 | 14 | 4 |
| 17 | 47 | 65320 | 75719 | 66632 | 74567 | 67923 | 73393 | 69193 | 72196 | 70443 | 70978 | 13 | 4 |
| 18 | 48 | 65342 | 75700 | 66653 | 74548 | 67944 | 73373 | 69214 | 72176 | 70463 | 70957 | 12 | 4 |
| 18 | 49 | 65364 | 75680 | 66675 | 74528 | 67965 | 73353 | 69235 | 72156 | 70484 | 70937 | 11 | 3 |
| 18 | 50 | 65386 | 75661 | 66697 | 74509 | 67987 | 73333 | 69256 | 72136 | 70505 | 70916 | 10 | 3 |
| 19 | 51 | 65408 | 75642 | 66718 | 74489 | 68008 | 73314 | 69277 | 72116 | 70525 | 70896 | 9 | 3 |
| 19 | 52 | 65430 | 75623 | 66740 | 74470 | 68029 | 73294 | 69298 | 72095 | 70546 | 70875 | 8 | 3 |
| 19 | 53 | 65452 | 75604 | 66762 | 74451 | 68051 | 73274 | 69319 | 72075 | 70567 | 70855 | 7 | 2 |
| 20 | 54 | 65474 | 75585 | 66783 | 74431 | 68072 | 73254 | 69340 | 72055 | 70587 | 70834 | 6 | 2 |
| 20 | 55 | 65496 | 75566 | 66805 | 74412 | 68093 | 73234 | 69361 | 72035 | 70608 | 70813 | 5 | 2 |
| 21 | 56 | 65518 | ·75547 | 66827 | 74392 | 68115 | 73215 | 69382 | 72015 | 70628 | 70793 | 4 | 1 |
| 21 | 57 | 65540 | 75528 | 66848 | 74373 | 68136 | 73195 | 69403 | 71995 | ·70649 | 70772 | 3 | 1 |
| 21 | 58 | 65562 | 75509 | 66870 | 74353 | 68157 | 73175 | 69424 | 71974 | 70670 | 70752 | 2 | 1 |
| 22 | 59 | 65584 | 75490 | 66891 | 74334 | 68179 | 73155 | 69445 | 71954 | 70690 | 70731 | 1 | 0 |
| 22 | 60 | 65606 | 75471 | 66913 | 74314 | 68200 | 73135 | 69466 | 71934 | 70711 | 70711 | 0 | 0 |
| | | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N. cos. | N. sine. | N.cos. | N. sine. | M. | |
| | | 49° | | 48° | | 47° | | 46° | | 45° | | | |

TABLE 42. [Page 591

## Logarithms of Numbers.

| No. | Log. | No. | Log. | No. | Log. | No. | Log. | No. | Log. |
|-----|------|-----|------|-----|------|-----|------|-----|------|
| 1 | 0.00000 | 21 | 1.32222 | 41 | 1.61278 | 61 | 1.78533 | 81 | 1.90849 |
| 2 | 0.30103 | 22 | 1.34242 | 42 | 1.62325 | 62 | 1.79239 | 82 | 1.91381 |
| 3 | 0.47712 | 23 | 1.36173 | 43 | 1.63347 | 63 | 1.79934 | 83 | 1.91908 |
| 4 | 0.60206 | 24 | 1.38021 | 44 | 1.64345 | 64 | 1.80618 | 84 | 1.92428 |
| 5 | 0.69897 | 25 | 1.39794 | 45 | 1.65321 | 65 | 1.81291 | 85 | 1.92942 |
| 6 | 0.77815 | 26 | 1.41497 | 46 | 1.66276 | 66 | 1.81954 | 86 | 1.93450 |
| 7 | 0.84510 | 27 | 1.43136 | 47 | 1.67210 | 67 | 1.82607 | 87 | 1.93952 |
| 8 | 0.90309 | 28 | 1.44716 | 48 | 1.68124 | 68 | 1.83251 | 88 | 1.94448 |
| 9 | 0.95424 | 29 | 1.46240 | 49 | 1.69020 | 69 | 1.83885 | 89 | 1.94939 |
| 10 | 1.00000 | 30 | 1.47712 | 50 | 1.69897 | 70 | 1.84510 | 90 | 1.95424 |
| 11 | 1.04139 | 31 | 1.49136 | 51 | 1.70757 | 71 | 1.85126 | 91 | 1.95904 |
| 12 | 1.07918 | 32 | 1.50515 | 52 | 1.71600 | 72 | 1.85733 | 92 | 1.96379 |
| 13 | 1.11394 | 33 | 1.51851 | 53 | 1.72428 | 73 | 1.86332 | 93 | 1.96848 |
| 14 | 1.14613 | 34 | 1.53148 | 54 | 1.73239 | 74 | 1.86923 | 94 | 1.97313 |
| 15 | 1.17609 | 35 | 1.54407 | 55 | 1.74036 | 75 | 1.87506 | 95 | 1.97772 |
| 16 | 1.20412 | 36 | 1.55630 | 56 | 1.74819 | 76 | 1.88081 | 96 | 1.98227 |
| 17 | 1.23045 | 37 | 1.56820 | 57 | 1.75587 | 77 | 1.88649 | 97 | 1.98677 |
| 18 | 1.25527 | 38 | 1.57978 | 58 | 1.76343 | 78 | 1.89209 | 98 | 1.99123 |
| 19 | 1.27875 | 39 | 1.59106 | 59 | 1.77085 | 79 | 1.89763 | 99 | 1.99564 |
| 20 | 1.30103 | 40 | 1.60206 | 60 | 1.77815 | 80 | 1.90309 | 100 | 2.00000 |

# TABLE 42.

## Logarithms of Numbers.

No. 100——1600.                                                      Log. 00000——20412.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 00000 | 00043 | 00087 | 00130 | 00173 | 00217 | 00260 | 00303 | 00346 | 00389 |
| 101 | 00432 | 00475 | 00518 | 00561 | 00604 | 00647 | 00689 | 00732 | 00775 | 00817 |
| 102 | 00860 | 00903 | 00945 | 00988 | 01030 | 01072 | 01115 | 01157 | 01199 | 01242 |
| 103 | 01284 | 01326 | 01368 | 01410 | 01452 | 01494 | 01536 | 01578 | 01620 | 01662 |
| 104 | 01703 | 01745 | 01787 | 01828 | 01870 | 01912 | 01953 | 01995 | 02036 | 02078 |
| 105 | 02119 | 02160 | 02202 | 02243 | 02284 | 02325 | 02366 | 02407 | 02449 | 02490 |
| 106 | 02531 | 02572 | 02612 | 02653 | 02694 | 02735 | 02776 | 02816 | 02857 | 02898 |
| 107 | 02938 | 02979 | 03019 | 03060 | 03100 | 03141 | 03181 | 03222 | 03262 | 03302 |
| 108 | 03342 | 03383 | 03423 | 03463 | 03503 | 03543 | 03583 | 03623 | 03663 | 03703 |
| 109 | 03743 | 03782 | 03822 | 03862 | 03902 | 03941 | 03981 | 04021 | 04060 | 04100 |
| 110 | 04139 | 04179 | 04218 | 04258 | 04297 | 04336 | 04376 | 04415 | 04454 | 04493 |
| 111 | 04532 | 04571 | 04610 | 04650 | 04689 | 04727 | 04766 | 04805 | 04844 | 04883 |
| 112 | 04922 | 04961 | 04999 | 05038 | 05077 | 05115 | 05154 | 05192 | 05231 | 05269 |
| 113 | 05308 | 05346 | 05385 | 05423 | 05461 | 05500 | 05538 | 05576 | 05614 | 05652 |
| 114 | 05690 | 05729 | 05767 | 05805 | 05843 | 05881 | 05918 | 05956 | 05994 | 06032 |
| 115 | 06070 | 06108 | 06145 | 06183 | 06221 | 06258 | 06296 | 06333 | 06371 | 06408 |
| 116 | 06446 | 06483 | 06521 | 06558 | 06595 | 06633 | 06670 | 06707 | 06744 | 06781 |
| 117 | 06819 | 06856 | 06893 | 06930 | 06967 | 07004 | 07041 | 07078 | 07115 | 07151 |
| 118 | 07188 | 07225 | 07262 | 07298 | 07335 | 07372 | 07408 | 07445 | 07482 | 07518 |
| 119 | 07555 | 07591 | 07628 | 07664 | 07700 | 07737 | 07773 | 07809 | 07846 | 07882 |
| 120 | 07918 | 07954 | 07990 | 08027 | 08063 | 08099 | 08135 | 08171 | 08207 | 08243 |
| 121 | 08279 | 08314 | 08350 | 08386 | 08422 | 08458 | 08493 | 08529 | 08565 | 08600 |
| 122 | 08636 | 08672 | 08707 | 08743 | 08778 | 08814 | 08849 | 08884 | 08920 | 08955 |
| 123 | 08991 | 09026 | 09061 | 09096 | 09132 | 09167 | 09202 | 09237 | 09272 | 09307 |
| 124 | 09342 | 09377 | 09412 | 09447 | 09482 | 09517 | 09552 | 09587 | 09621 | 09656 |
| 125 | 09691 | 09726 | 09760 | 09795 | 09830 | 09864 | 09899 | 09934 | 09968 | 10003 |
| 126 | 10037 | 10072 | 10106 | 10140 | 10175 | 10209 | 10243 | 10278 | 10312 | 10346 |
| 127 | 10380 | 10415 | 10449 | 10483 | 10517 | 10551 | 10585 | 10619 | 10653 | 10687 |
| 128 | 10721 | 10755 | 10789 | 10823 | 10857 | 10890 | 10924 | 10958 | 10992 | 11025 |
| 129 | 11059 | 11093 | 11126 | 11160 | 11193 | 11227 | 11261 | 11294 | 11327 | 11361 |
| 130 | 11394 | 11428 | 11461 | 11494 | 11528 | 11561 | 11594 | 11628 | 11661 | 11694 |
| 131 | 11727 | 11760 | 11793 | 11826 | 11860 | 11893 | 11926 | 11959 | 11992 | 12024 |
| 132 | 12057 | 12090 | 12123 | 12156 | 12189 | 12222 | 12254 | 12287 | 12320 | 12352 |
| 133 | 12385 | 12418 | 12450 | 12483 | 12516 | 12548 | 12581 | 12613 | 12646 | 12678 |
| 134 | 12710 | 12743 | 12775 | 12808 | 12840 | 12872 | 12905 | 12937 | 12969 | 13001 |
| 135 | 13033 | 13066 | 13098 | 13130 | 13162 | 13194 | 13226 | 13258 | 13290 | 13322 |
| 136 | 13354 | 13386 | 13418 | 13450 | 13481 | 13513 | 13545 | 13577 | 13609 | 13640 |
| 137 | 13672 | 13704 | 13735 | 13767 | 13799 | 13830 | 13862 | 13893 | 13925 | 13956 |
| 138 | 13988 | 14019 | 14051 | 14082 | 14114 | 14145 | 14176 | 14208 | 14239 | 14270 |
| 139 | 14301 | 14333 | 14364 | 14395 | 14426 | 14457 | 14489 | 14520 | 14551 | 14582 |
| 140 | 14613 | 14644 | 14675 | 14706 | 14737 | 14768 | 14799 | 14829 | 14860 | 14891 |
| 141 | 14922 | 14953 | 14983 | 15014 | 15045 | 15076 | 15106 | 15137 | 15168 | 15198 |
| 142 | 15229 | 15259 | 15290 | 15320 | 15351 | 15381 | 15412 | 15442 | 15473 | 15503 |
| 143 | 15534 | 15564 | 15594 | 15625 | 15655 | 15685 | 15715 | 15746 | 15776 | 15806 |
| 144 | 15836 | 15866 | 15897 | 15927 | 15957 | 15987 | 16017 | 16047 | 16077 | 16107 |
| 145 | 16137 | 16167 | 16197 | 16227 | 16256 | 16286 | 16316 | 16346 | 16376 | 16406 |
| 146 | 16435 | 16465 | 16495 | 16524 | 16554 | 16584 | 16613 | 16643 | 16673 | 16702 |
| 147 | 16732 | 16761 | 16791 | 16820 | 16850 | 16879 | 16909 | 16938 | 16967 | 16997 |
| 148 | 17026 | 17056 | 17085 | 17114 | 17143 | 17173 | 17202 | 17231 | 17260 | 17289 |
| 149 | 17319 | 17348 | 17377 | 17406 | 17435 | 17464 | 17493 | 17522 | 17551 | 17580 |
| 150 | 17609 | 17638 | 17667 | 17696 | 17725 | 17754 | 17782 | 17811 | 17840 | 17869 |
| 151 | 17898 | 17926 | 17955 | 17984 | 18013 | 18041 | 18070 | 18099 | 18127 | 18156 |
| 152 | 18184 | 18213 | 18241 | 18270 | 18298 | 18327 | 18355 | 18384 | 18412 | 18441 |
| 153 | 18469 | 18498 | 18526 | 18554 | 18583 | 18611 | 18639 | 18667 | 18696 | 18724 |
| 154 | 18752 | 18780 | 18808 | 18837 | 18865 | 18893 | 18921 | 18949 | 18977 | 19005 |
| 155 | 19033 | 19061 | 19089 | 19117 | 19145 | 19173 | 19201 | 19229 | 19257 | 19285 |
| 156 | 19312 | 19340 | 19368 | 19396 | 19424 | 19451 | 19479 | 19507 | 19535 | 19562 |
| 157 | 19590 | 19618 | 19645 | 19673 | 19700 | 19728 | 19756 | 19783 | 19811 | 19838 |
| 158 | 19866 | 19893 | 19921 | 19948 | 19976 | 20003 | 20030 | 20058 | 20085 | 20112 |
| 159 | 20140 | 20167 | 20194 | 20222 | 20249 | 20276 | 20303 | 20330 | 20358 | 20385 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

### Proportional Parts

| | 43 | 42 |
|---|---|---|
| 1 | 4 | 4 |
| 2 | 9 | 8 |
| 3 | 13 | 13 |
| 4 | 17 | 17 |
| 5 | 22 | 21 |
| 6 | 26 | 25 |
| 7 | 30 | 29 |
| 8 | 34 | 34 |
| 9 | 39 | 38 |

| | 41 | 40 |
|---|---|---|
| 1 | 4 | 4 |
| 2 | 8 | 8 |
| 3 | 12 | 12 |
| 4 | 16 | 16 |
| 5 | 21 | 20 |
| 6 | 25 | 24 |
| 7 | 29 | 28 |
| 8 | 33 | 32 |
| 9 | 37 | 36 |

| | 39 | 38 |
|---|---|---|
| 1 | 4 | 4 |
| 2 | 8 | 8 |
| 3 | 12 | 11 |
| 4 | 16 | 15 |
| 5 | 20 | 19 |
| 6 | 23 | 23 |
| 7 | 27 | 27 |
| 8 | 31 | 30 |
| 9 | 35 | 34 |

| | 37 | 36 |
|---|---|---|
| 1 | 4 | 4 |
| 2 | 7 | 7 |
| 3 | 11 | 11 |
| 4 | 15 | 14 |
| 5 | 19 | 18 |
| 6 | 22 | 22 |
| 7 | 26 | 25 |
| 8 | 30 | 29 |
| 9 | 33 | 32 |

| | 35 | 34 |
|---|---|---|
| 1 | 4 | 3 |
| 2 | 7 | 7 |
| 3 | 11 | 10 |
| 4 | 14 | 14 |
| 5 | 18 | 17 |
| 6 | 21 | 20 |
| 7 | 25 | 24 |
| 8 | 28 | 27 |
| 9 | 32 | 31 |

| | 33 | 32 |
|---|---|---|
| 1 | 3 | 3 |
| 2 | 7 | 6 |
| 3 | 10 | 10 |
| 4 | 13 | 13 |
| 5 | 17 | 16 |
| 6 | 20 | 19 |
| 7 | 23 | 22 |
| 8 | 26 | 26 |
| 9 | 30 | 29 |

# TABLE 42.

## Logarithms of Numbers.

No. 1600——2200.  Log. 20412——34242.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 160 | 20412 | 20439 | 20466 | 20493 | 20520 | 20548 | 20575 | 20602 | 20629 | 20656 |
| 161 | 20683 | 20710 | 20737 | 20763 | 20790 | 20817 | 20844 | 20871 | 20898 | 20925 |
| 162 | 20952 | 20978 | 21005 | 21032 | 21059 | 21085 | 21112 | 21139 | 21165 | 21192 |
| 163 | 21219 | 21245 | 21272 | 21299 | 21325 | 21352 | 21378 | 21405 | 21431 | 21458 |
| 164 | 21484 | 21511 | 21537 | 21564 | 21590 | 21617 | 21643 | 21669 | 21696 | 21722 |
| 165 | 21748 | 21775 | 21801 | 21827 | 21854 | 21880 | 21906 | 21932 | 21958 | 21985 |
| 166 | 22011 | 22037 | 22063 | 22089 | 22115 | 22141 | 22167 | 22194 | 22220 | 22246 |
| 167 | 22272 | 22298 | 22324 | 22350 | 22376 | 22401 | 22427 | 22453 | 22479 | 22505 |
| 168 | 22531 | 22557 | 22583 | 22608 | 22634 | 22660 | 22686 | 22712 | 22737 | 22763 |
| 169 | 22789 | 22814 | 22840 | 22866 | 22891 | 22917 | 22943 | 22968 | 22994 | 23019 |
| 170 | 23045 | 23070 | 23096 | 23121 | 23147 | 23172 | 23198 | 23223 | 23249 | 23274 |
| 171 | 23300 | 23325 | 23350 | 23376 | 23401 | 23426 | 23452 | 23477 | 23502 | 23528 |
| 172 | 23553 | 23578 | 23603 | 23629 | 23654 | 23679 | 23704 | 23729 | 23754 | 23779 |
| 173 | 23805 | 23830 | 23855 | 23880 | 23905 | 23930 | 23955 | 23980 | 24005 | 24030 |
| 174 | 24055 | 24080 | 24105 | 24130 | 24155 | 24180 | 24204 | 24229 | 24254 | 24279 |
| 175 | 24304 | 24329 | 24353 | 24378 | 24403 | 24428 | 24452 | 24477 | 24502 | 24527 |
| 176 | 24551 | 24576 | 24601 | 24625 | 24650 | 24674 | 24699 | 24724 | 24748 | 24773 |
| 177 | 24797 | 24822 | 24846 | 24871 | 24895 | 24920 | 24944 | 24969 | 24993 | 25018 |
| 178 | 25042 | 25066 | 25091 | 25115 | 25139 | 25164 | 25188 | 25212 | 25237 | 25261 |
| 179 | 25285 | 25310 | 25334 | 25358 | 25382 | 25406 | 25431 | 25455 | 25479 | 25503 |
| 180 | 25527 | 25551 | 25575 | 25600 | 25624 | 25648 | 25672 | 25696 | 25720 | 25744 |
| 181 | 25768 | 25792 | 25816 | 25840 | 25864 | 25888 | 25912 | 25935 | 25959 | 25983 |
| 182 | 26007 | 26031 | 26055 | 26079 | 26102 | 26126 | 26150 | 26174 | 26198 | 26221 |
| 183 | 26245 | 26269 | 26293 | 26316 | 26340 | 26364 | 26387 | 26411 | 26435 | 26458 |
| 184 | 26482 | 26505 | 26529 | 26553 | 26576 | 26600 | 26623 | 26647 | 26670 | 26694 |
| 185 | 26717 | 26741 | 26764 | 26788 | 26811 | 26834 | 26858 | 26881 | 26905 | 26928 |
| 186 | 26951 | 26975 | 26998 | 27021 | 27045 | 27068 | 27091 | 27114 | 27138 | 27161 |
| 187 | 27184 | 27207 | 27231 | 27254 | 27277 | 27300 | 27323 | 27346 | 27370 | 27393 |
| 188 | 27416 | 27439 | 27462 | 27485 | 27508 | 27531 | 27554 | 27577 | 27600 | 27623 |
| 189 | 27646 | 27669 | 27692 | 27715 | 27738 | 27761 | 27784 | 27807 | 27830 | 27852 |
| 190 | 27875 | 27898 | 27921 | 27944 | 27967 | 27989 | 28012 | 28035 | 28058 | 28081 |
| 191 | 28103 | 28126 | 28149 | 28171 | 28194 | 28217 | 28240 | 28262 | 28285 | 28307 |
| 192 | 28330 | 28353 | 28375 | 28398 | 28421 | 28443 | 28466 | 28488 | 28511 | 28533 |
| 193 | 28556 | 28578 | 28601 | 28623 | 28646 | 28668 | 28691 | 28713 | 28735 | 28758 |
| 194 | 28780 | 28803 | 28825 | 28847 | 28870 | 28892 | 28914 | 28937 | 28959 | 28981 |
| 195 | 29003 | 29026 | 29048 | 29070 | 29092 | 29115 | 29137 | 29159 | 29181 | 29203 |
| 196 | 29226 | 29248 | 29270 | 29292 | 29314 | 29336 | 29358 | 29380 | 29403 | 29425 |
| 197 | 29447 | 29469 | 29491 | 29513 | 29535 | 29557 | 29579 | 29601 | 29623 | 29645 |
| 198 | 29667 | 29688 | 29710 | 29732 | 29754 | 29776 | 29798 | 29820 | 29842 | 29863 |
| 199 | 29885 | 29907 | 29929 | 29951 | 29973 | 29994 | 30016 | 30038 | 30060 | 30081 |
| 200 | 30103 | 30125 | 30146 | 30168 | 30190 | 30211 | 30233 | 30255 | 30276 | 30298 |
| 201 | 30320 | 30341 | 30363 | 30384 | 30406 | 30428 | 30449 | 30471 | 30492 | 30514 |
| 202 | 30535 | 30557 | 30578 | 30600 | 30621 | 30643 | 30664 | 30685 | 30707 | 30728 |
| 203 | 30750 | 30771 | 30792 | 30814 | 30835 | 30856 | 30878 | 30899 | 30920 | 30942 |
| 204 | 30963 | 30984 | 31006 | 31027 | 31048 | 31069 | 31091 | 31112 | 31133 | 31154 |
| 205 | 31175 | 31197 | 31218 | 31239 | 31260 | 31281 | 31302 | 31323 | 31345 | 31366 |
| 206 | 31387 | 31408 | 31429 | 31450 | 31471 | 31492 | 31513 | 31534 | 31555 | 31576 |
| 207 | 31597 | 31618 | 31639 | 31660 | 31681 | 31702 | 31723 | 31744 | 31765 | 31785 |
| 208 | 31806 | 31827 | 31848 | 31869 | 31890 | 31911 | 31931 | 31952 | 31973 | 31994 |
| 209 | 32015 | 32035 | 32056 | 32077 | 32098 | 32118 | 32139 | 32160 | 32181 | 32201 |
| 210 | 32222 | 32243 | 32263 | 32284 | 32305 | 32325 | 32346 | 32366 | 32387 | 32408 |
| 211 | 32428 | 32449 | 32469 | 32490 | 32510 | 32531 | 32552 | 32572 | 32593 | 32613 |
| 212 | 32634 | 32654 | 32675 | 32695 | 32715 | 32736 | 32756 | 32777 | 32797 | 32818 |
| 213 | 32838 | 32858 | 32879 | 32899 | 32919 | 32940 | 32960 | 32980 | 33001 | 33021 |
| 214 | 33041 | 33062 | 33082 | 33102 | 33122 | 33143 | 33163 | 33183 | 33203 | 33224 |
| 215 | 33244 | 33264 | 33284 | 33304 | 33325 | 33345 | 33365 | 33385 | 33405 | 33425 |
| 216 | 33445 | 33465 | 33486 | 33506 | 33526 | 33546 | 33566 | 33586 | 33606 | 33626 |
| 217 | 33646 | 33666 | 33686 | 33706 | 33726 | 33746 | 33766 | 33786 | 33806 | 33826 |
| 218 | 33846 | 33866 | 33885 | 33905 | 33925 | 33945 | 33965 | 33985 | 34005 | 34025 |
| 219 | 34044 | 34064 | 34084 | 34104 | 34124 | 34143 | 34163 | 34183 | 34203 | 34223 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Proportional parts:

| | 31 | 30 | | 29 | 28 | | 27 | 26 | | 25 | 24 | | 23 | 22 | | 21 | 20 |
|---|----|----|---|----|----|---|----|----|---|----|----|---|----|----|---|----|----|
| 1 | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 2 |
| 2 | 6 | 6 | 2 | 6 | 6 | 2 | 5 | 5 | 2 | 5 | 5 | 2 | 5 | 4 | 2 | 4 | 4 |
| 3 | 9 | 9 | 3 | 9 | 8 | 3 | 8 | 8 | 3 | 8 | 7 | 3 | 7 | 7 | 3 | 6 | 6 |
| 4 | 12 | 12 | 4 | 12 | 11 | 4 | 11 | 10 | 4 | 10 | 10 | 4 | 9 | 9 | 4 | 8 | 8 |
| 5 | 16 | 15 | 5 | 15 | 14 | 5 | 14 | 13 | 5 | 13 | 12 | 5 | 12 | 11 | 5 | 11 | 10 |
| 6 | 19 | 18 | 6 | 17 | 17 | 6 | 16 | 16 | 6 | 15 | 14 | 6 | 14 | 13 | 6 | 13 | 12 |
| 7 | 22 | 21 | 7 | 20 | 20 | 7 | 19 | 18 | 7 | 18 | 17 | 7 | 16 | 15 | 7 | 15 | 14 |
| 8 | 25 | 24 | 8 | 23 | 22 | 8 | 22 | 21 | 8 | 20 | 19 | 8 | 18 | 18 | 8 | 17 | 16 |
| 9 | 28 | 27 | 9 | 26 | 25 | 9 | 24 | 23 | 9 | 23 | 22 | 9 | 21 | 20 | 9 | 19 | 18 |

# TABLE 42.

### Logarithms of Numbers.

No. 2200——2800.  Log. 34242——44716.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 220 | 34242 | 34262 | 34282 | 34301 | 34321 | 34341 | 34361 | 34380 | 34400 | 34420 |
| 221 | 34439 | 34459 | 34479 | 34498 | 34518 | 34537 | 34557 | 34577 | 34596 | 34616 |
| 222 | 34635 | 34655 | 34674 | 34694 | 34713 | 34733 | 34753 | 34772 | 34792 | 34811 |
| 223 | 34830 | 34850 | 34869 | 34889 | 34908 | 34928 | 34947 | 34967 | 34986 | 35005 |
| 224 | 35025 | 35044 | 35064 | 35083 | 35102 | 35122 | 35141 | 35160 | 35180 | 35199 |
| 225 | 35218 | 35238 | 35257 | 35276 | 35295 | 35315 | 35334 | 35353 | 35372 | 35392 |
| 226 | 35411 | 35430 | 35449 | 35468 | 35488 | 35507 | 35526 | 35545 | 35564 | 35583 |
| 227 | 35603 | 35622 | 35641 | 35660 | 35679 | 35698 | 35717 | 35736 | 35755 | 35774 |
| 228 | 35793 | 35813 | 35832 | 35851 | 35870 | 35889 | 35908 | 35927 | 35946 | 35965 |
| 229 | 35984 | 36003 | 36021 | 36040 | 36059 | 36078 | 36097 | 36116 | 36135 | 36154 |
| 230 | 36173 | 36192 | 36211 | 36229 | 36248 | 36267 | 36286 | 36305 | 36324 | 36342 |
| 231 | 36361 | 36380 | 36399 | 36418 | 36436 | 36455 | 36474 | 36493 | 36511 | 36530 |
| 232 | 36549 | 36568 | 36586 | 36605 | 36624 | 36642 | 36661 | 36680 | 36698 | 36717 |
| 233 | 36736 | 36754 | 36773 | 36791 | 36810 | 36829 | 36847 | 36866 | 36884 | 36903 |
| 234 | 36922 | 36940 | 36959 | 36977 | 36996 | 37014 | 37033 | 37051 | 37070 | 37088 |
| 235 | 37107 | 37125 | 37144 | 37162 | 37181 | 37199 | 37218 | 37236 | 37254 | 37273 |
| 236 | 37291 | 37310 | 37328 | 37346 | 37365 | 37383 | 37401 | 37420 | 37438 | 37457 |
| 237 | 37475 | 37493 | 37511 | 37530 | 37548 | 37566 | 37585 | 37603 | 37621 | 37639 |
| 238 | 37658 | 37676 | 37694 | 37712 | 37731 | 37749 | 37767 | 37785 | 37803 | 37822 |
| 239 | 37840 | 37858 | 37876 | 37894 | 37912 | 37931 | 37949 | 37967 | 37985 | 38003 |
| 240 | 38021 | 38039 | 38057 | 38075 | 38093 | 38112 | 38130 | 38148 | 38166 | 38184 |
| 241 | 38202 | 38220 | 38238 | 38256 | 38274 | 38292 | 38310 | 38328 | 38346 | 38364 |
| 242 | 38382 | 38399 | 38417 | 38435 | 38453 | 38471 | 38489 | 38507 | 38525 | 38543 |
| 243 | 38561 | 38578 | 38596 | 38614 | 38632 | 38650 | 38668 | 38686 | 38703 | 38721 |
| 244 | 38739 | 38757 | 38775 | 38792 | 38810 | 38828 | 38846 | 38863 | 38881 | 38899 |
| 245 | 38917 | 38934 | 38952 | 38970 | 38987 | 39005 | 39023 | 39041 | 39058 | 39076 |
| 246 | 39094 | 39111 | 39129 | 39146 | 39164 | 39182 | 39199 | 39217 | 39235 | 39252 |
| 247 | 39270 | 39287 | 39305 | 39322 | 39340 | 39358 | 39375 | 39393 | 39410 | 39428 |
| 248 | 39445 | 39463 | 39480 | 39498 | 39515 | 39533 | 39550 | 39568 | 39585 | 39602 |
| 249 | 39620 | 39637 | 39655 | 39672 | 39690 | 39707 | 39724 | 39742 | 39759 | 39777 |
| 250 | 39794 | 39811 | 39829 | 39846 | 39863 | 39881 | 39898 | 39915 | 39933 | 39950 |
| 251 | 39967 | 39985 | 40002 | 40019 | 40037 | 40054 | 40071 | 40088 | 40106 | 40123 |
| 252 | 40140 | 40157 | 40175 | 40192 | 40209 | 40226 | 40243 | 40261 | 40278 | 40295 |
| 253 | 40312 | 40329 | 40346 | 40364 | 40381 | 40398 | 40415 | 40432 | 40449 | 40466 |
| 254 | 40483 | 40500 | 40518 | 40535 | 40552 | 40569 | 40586 | 40603 | 40620 | 40637 |
| 255 | 40654 | 40671 | 40688 | 40705 | 40722 | 40739 | 40756 | 40773 | 40790 | 40807 |
| 256 | 40824 | 40841 | 40858 | 40875 | 40892 | 40909 | 40926 | 40943 | 40960 | 40976 |
| 257 | 40993 | 41010 | 41027 | 41044 | 41061 | 41078 | 41095 | 41111 | 41128 | 41145 |
| 258 | 41162 | 41179 | 41196 | 41212 | 41229 | 41246 | 41263 | 41280 | 41296 | 41313 |
| 259 | 41330 | 41347 | 41363 | 41380 | 41397 | 41414 | 41430 | 41447 | 41464 | 41481 |
| 260 | 41497 | 41514 | 41531 | 41547 | 41564 | 41581 | 41597 | 41614 | 41631 | 41647 |
| 261 | 41664 | 41681 | 41697 | 41714 | 41731 | 41747 | 41764 | 41780 | 41797 | 41814 |
| 262 | 41830 | 41847 | 41863 | 41880 | 41896 | 41913 | 41929 | 41946 | 41963 | 41979 |
| 263 | 41996 | 42012 | 42029 | 42045 | 42062 | 42078 | 42095 | 42111 | 42127 | 42144 |
| 264 | 42160 | 42177 | 42193 | 42210 | 42226 | 42243 | 42259 | 42275 | 42292 | 42308 |
| 265 | 42325 | 42341 | 42357 | 42374 | 42390 | 42406 | 42423 | 42439 | 42455 | 42472 |
| 266 | 42488 | 42504 | 42521 | 42537 | 42553 | 42570 | 42586 | 42602 | 42619 | 42635 |
| 267 | 42651 | 42667 | 42684 | 42700 | 42716 | 42732 | 42749 | 42765 | 42781 | 42797 |
| 268 | 42813 | 42830 | 42846 | 42862 | 42878 | 42894 | 42911 | 42927 | 42943 | 42959 |
| 269 | 42975 | 42991 | 43008 | 43024 | 43040 | 43056 | 43072 | 43088 | 43104 | 43120 |
| 270 | 43136 | 43152 | 43169 | 43185 | 43201 | 43217 | 43233 | 43249 | 43265 | 43281 |
| 271 | 43297 | 43313 | 43329 | 43345 | 43361 | 43377 | 43393 | 43409 | 43425 | 43441 |
| 272 | 43457 | 43473 | 43489 | 43505 | 43521 | 43537 | 43553 | 43569 | 43584 | 43600 |
| 273 | 43616 | 43632 | 43648 | 43664 | 43680 | 43696 | 43712 | 43727. | 43743 | 43759 |
| 274 | 43775 | 43791 | 43807 | 43823 | 43838 | 43854 | 43870 | 43886 | 43902 | 43917 |
| 275 | 43933 | 43949 | 43965 | 43981 | 43996 | 44012 | 44028 | 44044 | 44059 | 44075 |
| 276 | 44091 | 44107 | 44122 | 44138 | 44154 | 44170 | 44185 | 44201 | 44217 | 44232 |
| 277 | 44248 | 44264 | 44279 | 44295 | 44311 | 44326 | 44342 | 44358 | 44373 | 44389 |
| 278 | 44404 | 44420 | 44436 | 44451 | 44467 | 44483 | 44498 | 44514 | 44529 | 44545 |
| 279 | 44560 | 44576 | 44592 | 44607 | 44623 | 44638 | 44654 | 44669 | 44685 | 44700 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Proportional parts:

| | 20 | | 19 | | 18 | | 17 | | 16 | | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 2 | 4 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 3 | 2 | 3 |
| 3 | 6 | 3 | 6 | 3 | 5 | 3 | 5 | 3 | 5 | 3 | 5 |
| 4 | 8 | 4 | 8 | 4 | 7 | 4 | 7 | 4 | 6 | 4 | 6 |
| 5 | 10 | 5 | 10 | 5 | 9 | 5 | 9 | 5 | 8 | 5 | 8 |
| 6 | 12 | 6 | 11 | 6 | 11 | 6 | 10 | 6 | 10 | 6 | 9 |
| 7 | 14 | 7 | 13 | 7 | 13 | 7 | 12 | 7 | 11 | 7 | 11 |
| 8 | 16 | 8 | 15 | 8 | 14 | 8 | 14 | 8 | 13 | 8 | 12 |
| 9 | 18 | 9 | 17 | 9 | 16 | 9 | 15 | 9 | 14 | 9 | 14 |

TABLE 42. [Page 595

Logarithms of Numbers.

No. 2800——3400.                                                                 Log. 44716——53148.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 280 | 44716 | 44731 | 44747 | 44762 | 44778 | 44793 | 44809 | 44824 | 44840 | 44855 |
| 281 | 44871 | 44886 | 44902 | 44917 | 44932 | 44948 | 44963 | 44979 | 44994 | 45010 |
| 282 | 45025 | 45040 | 45056 | 45071 | 45086 | 45102 | 45117 | 45133 | 45148 | 45163 |
| 283 | 45179 | 45194 | 45209 | 45225 | 45240 | 45255 | 45271 | 45286 | 45301 | 45317 |
| 284 | 45332 | 45347 | 45362 | 45378 | 45393 | 45408 | 45423 | 45439 | 45454 | 45469 |
| 285 | 45484 | 45500 | 45515 | 45530 | 45545 | 45561 | 45576 | 45591 | 45606 | 45621 |
| 286 | 45637 | 45652 | 45667 | 45682 | 45697 | 45712 | 45728 | 45743 | 45758 | 45773 |
| 287 | 45788 | 45803 | 45818 | 45834 | 45849 | 45864 | 45879 | 45894 | 45909 | 45924 |
| 288 | 45939 | 45954 | 45969 | 45984 | 46000 | 46015 | 46030 | 46045 | 46060 | 46075 |
| 289 | 46090 | 46105 | 46120 | 46135 | 46150 | 46165 | 46180 | 46195 | 46210 | 46225 |
| 290 | 46240 | 46255 | 46270 | 46285 | 46300 | 46315 | 46330 | 46345 | 46359 | 46374 |
| 291 | 46389 | 46404 | 46419 | 46434 | 46449 | 46464 | 46479 | 46494 | 46509 | 46523 |
| 292 | 46538 | 46553 | 46568 | 46583 | 46598 | 46613 | 46627 | 46642 | 46657 | 46672 |
| 293 | 46687 | 46702 | 46716 | 46731 | 46746 | 46761 | 46776 | 46790 | 46805 | 46820 |
| 294 | 46835 | 46850 | 46864 | 46879 | 46894 | 46909 | 46923 | 46938 | 46953 | 46967 |
| 295 | 46982 | 46997 | 47012 | 47026 | 47041 | 47056 | 47070 | 47085 | 47100 | 47114 |
| 296 | 47129 | 47144 | 47159 | 47173 | 47188 | 47202 | 47217 | 47232 | 47246 | 47261 |
| 297 | 47276 | 47290 | 47305 | 47319 | 47334 | 47349 | 47363 | 47378 | 47392 | 47407 |
| 298 | 47422 | 47436 | 47451 | 47465 | 47480 | 47494 | 47509 | 47524 | 47538 | 47553 |
| 299 | 47567 | 47582 | 47596 | 47611 | 47625 | 47640 | 47654 | 47669 | 47683 | 47698 |
| 300 | 47712 | 47727 | 47741 | 47756 | 47770 | 47784 | 47799 | 47813 | 47828 | 47842 |
| 301 | 47857 | 47871 | 47885 | 47900 | 47914 | 47929 | 47943 | 47958 | 47972 | 47986 |
| 302 | 48001 | 48015 | 48029 | 48044 | 48058 | 48073 | 48087 | 48101 | 48116 | 48130 |
| 303 | 48144 | 48159 | 48173 | 48187 | 48202 | 48216 | 48230 | 48244 | 48259 | 48273 |
| 304 | 48287 | 48302 | 48316 | 48330 | 48344 | 48359 | 48373 | 48387 | 48401 | 48416 |
| 305 | 48430 | 48444 | 48458 | 48473 | 48487 | 48501 | 48515 | 48530 | 48544 | 48558 |
| 306 | 48572 | 48586 | 48601 | 48615 | 48629 | 48643 | 48657 | 48671 | 48686 | 48700 |
| 307 | 48714 | 48728 | 48742 | 48756 | 48770 | 48785 | 48799 | 48813 | 48827 | 48841 |
| 308 | 48855 | 48869 | 48883 | 48897 | 48911 | 48926 | 48940 | 48954 | 48968 | 48982 |
| 309 | 48996 | 49010 | 49024 | 49038 | 49052 | 49066 | 49080 | 49094 | 49108 | 49122 |
| 310 | 49136 | 49150 | 49164 | 49178 | 49192 | 49206 | 49220 | 49234 | 49248 | 49262 |
| 311 | 49276 | 49290 | 49304 | 49318 | 49332 | 49346 | 49360 | 49374 | 49388 | 49402 |
| 312 | 49415 | 49429 | 49443 | 49457 | 49471 | 49485 | 49499 | 49513 | 49527 | 49541 |
| 313 | 49554 | 49568 | 49582 | 49596 | 49610 | 49624 | 49638 | 49651 | 49665 | 49679 |
| 314 | 49693 | 49707 | 49721 | 49734 | 49748 | 49762 | 49776 | 49790 | 49803 | 49817 |
| 315 | 49831 | 49845 | 49859 | 49872 | 49886 | 49900 | 49914 | 49927 | 49941 | 49955 |
| 316 | 49969 | 49982 | 49996 | 50010 | 50024 | 50037 | 50051 | 50065 | 50079 | 50092 |
| 317 | 50106 | 50120 | 50133 | 50147 | 50161 | 50174 | 50188 | 50202 | 50215 | 50229 |
| 318 | 50243 | 50256 | 50270 | 50284 | 50297 | 50311 | 50325 | 50338 | 50352 | 50365 |
| 319 | 50379 | 50393 | 50406 | 50420 | 50433 | 50447 | 50461 | 50474 | 50488 | 50501 |
| 320 | 50515 | 50529 | 50542 | 50556 | 50569 | 50583 | 50596 | 50610 | 50623 | 50637 |
| 321 | 50651 | 50664 | 50678 | 50691 | 50705 | 50718 | 50732 | 50745 | 50759 | 50772 |
| 322 | 50786 | 50799 | 50813 | 50826 | 50840 | 50853 | 50866 | 50880 | 50893 | 50907 |
| 323 | 50920 | 50934 | 50947 | 50961 | 50974 | 50987 | 51001 | 51014 | 51028 | 51041 |
| 324 | 51055 | 51068 | 51081 | 51095 | 51108 | 51121 | 51135 | 51148 | 51162 | 51175 |
| 325 | 51188 | 51202 | 51215 | 51228 | 51242 | 51255 | 51268 | 51282 | 51295 | 51308 |
| 326 | 51322 | 51335 | 51348 | 51362 | 51375 | 51388 | 51402 | 51415 | 51428 | 51441 |
| 327 | 51455 | 51468 | 51481 | 51495 | 51508 | 51521 | 51534 | 51548 | 51561 | 51574 |
| 328 | 51587 | 51601 | 51614 | 51627 | 51640 | 51654 | 51667 | 51680 | 51693 | 51706 |
| 329 | 51720 | 51733 | 51746 | 51759 | 51772 | 51786 | 51799 | 51812 | 51825 | 51838 |
| 330 | 51851 | 51865 | 51878 | 51891 | 51904 | 51917 | 51930 | 51943 | 51957 | 51970 |
| 331 | 51983 | 51996 | 52009 | 52022 | 52035 | 52048 | 52061 | 52075 | 52088 | 52101 |
| 332 | 52114 | 52127 | 52140 | 52153 | 52166 | 52179 | 52192 | 52205 | 52218 | 52231 |
| 333 | 52244 | 52257 | 52270 | 52284 | 52297 | 52310 | 52323 | 52336 | 52349 | 52362 |
| 334 | 52375 | 52388 | 52401 | 52414 | 52427 | 52440 | 52453 | 52466 | 52479 | 52492 |
| 335 | 52504 | 52517 | 52530 | 52543 | 52556 | 52569 | 52582 | 52595 | 52608 | 52621 |
| 336 | 52634 | 52647 | 52660 | 52673 | 52686 | 52699 | 52711 | 52724 | 52737 | 52750 |
| 337 | 52763 | 52776 | 52789 | 52802 | 52815 | 52827 | 52840 | 52853 | 52866 | 52879 |
| 338 | 52892 | 52905 | 52917 | 52930 | 52943 | 52956 | 52969 | 52982 | 52994 | 53007 |
| 339 | 53020 | 53033 | 53046 | 53058 | 53071 | 53084 | 53097 | 53110 | 53122 | 53135 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Proportional parts:

| 16 | | 15 | | 14 | | 13 | | 12 | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| 3 | 5 | 3 | 5 | 3 | 4 | 3 | 4 | 3 | 4 |
| 4 | 6 | 4 | 6 | 4 | 6 | 4 | 5 | 4 | 5 |
| 5 | 8 | 5 | 8 | 5 | 7 | 5 | 7 | 5 | 6 |
| 6 | 10 | 6 | 9 | 6 | 8 | 6 | 8 | 6 | 7 |
| 7 | 11 | 7 | 11 | 7 | 10 | 7 | 9 | 7 | 8 |
| 8 | 13 | 8 | 12 | 8 | 11 | 8 | 10 | 8 | 10 |
| 9 | 14 | 9 | 14 | 9 | 13 | 9 | 12 | 9 | 11 |

# TABLE 42.

## Logarithms of Numbers.

No. 3400——4000.                                           Log. 53148——60206.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 340 | 53148 | 53161 | 53173 | 53186 | 53199 | 53212 | 53224 | 53237 | 53250 | 53263 |
| 341 | 53275 | 53288 | 53301 | 53314 | 53326 | 53339 | 53352 | 53364 | 53377 | 53390 |
| 342 | 53403 | 53415 | 53428 | 53441 | 53453 | 53466 | 53479 | 53491 | 53504 | 53517 |
| 343 | 53529 | 53542 | 53555 | 53567 | 53580 | 53593 | 53605 | 53618 | 53631 | 53643 |
| 344 | 53656 | 53668 | 53681 | 53694 | 53706 | 53719 | 53732 | 53744 | 53757 | 53769 |
| 345 | 53782 | 53794 | 53807 | 53820 | 53832 | 53845 | 53857 | 53870 | 53882 | 53895 |
| 346 | 53908 | 53920 | 53933 | 53945 | 53958 | 53970 | 53983 | 53995 | 54008 | 54020 |
| 347 | 54033 | 54045 | 54058 | 54070 | 54083 | 54095 | 54108 | 54120 | 54133 | 54145 |
| 348 | 54158 | 54170 | 54183 | 54195 | 54208 | 54220 | 54233 | 54245 | 54258 | 54270 |
| 349 | 54283 | 54295 | 54307 | 54320 | 54332 | 54345 | 54357 | 54370 | 54382 | 54394 |
| 350 | 54407 | 54419 | 54432 | 54444 | 54456 | 54469 | 54481 | 54494 | 54506 | 54518 |
| 351 | 54531 | 54543 | 54555 | 54568 | 54580 | 54593 | 54605 | 54617 | 54630 | 54642 |
| 352 | 54654 | 54667 | 54679 | 54691 | 54704 | 54716 | 54728 | 54741 | 54753 | 54765 |
| 353 | 54777 | 54790 | 54802 | 54814 | 54827 | 54839 | 54851 | 54864 | 54876 | 54888 |
| 354 | 54900 | 54913 | 54925 | 54937 | 54949 | 54962 | 54974 | 54986 | 54998 | 55011 |
| 355 | 55023 | 55035 | 55047 | 55060 | 55072 | 55084 | 55096 | 55108 | 55121 | 55133 |
| 356 | 55145 | 55157 | 55169 | 55182 | 55194 | 55206 | 55218 | 55230 | 55242 | 55255 |
| 357 | 55267 | 55279 | 55291 | 55303 | 55315 | 55328 | 55340 | 55352 | 55364 | 55376 |
| 358 | 55388 | 55400 | 55413 | 55425 | 55437 | 55449 | 55461 | 55473 | 55485 | 55497 |
| 359 | 55509 | 55522 | 55534 | 55546 | 55558 | 55570 | 55582 | 55594 | 55606 | 55618 |
| 360 | 55630 | 55642 | 55654 | 55666 | 55678 | 55691 | 55703 | 55715 | 55727 | 55739 |
| 361 | 55751 | 55763 | 55775 | 55787 | 55799 | 55811 | 55823 | 55835 | 55847 | 55859 |
| 362 | 55871 | 55883 | 55895 | 55907 | 55919 | 55931 | 55943 | 55955 | 55967 | 55979 |
| 363 | 55991 | 56003 | 56015 | 56027 | 56038 | 56050 | 56062 | 56074 | 56086 | 56098 |
| 364 | 56110 | 56122 | 56134 | 56146 | 56158 | 56170 | 56182 | 56194 | 56205 | 56217 |
| 365 | 56229 | 56241 | 56253 | 56265 | 56277 | 56289 | 56301 | 56312 | 56324 | 56336 |
| 366 | 56348 | 56360 | 56372 | 56384 | 56396 | 56407 | 56419 | 56431 | 56443 | 56455 |
| 367 | 56467 | 56478 | 56490 | 56502 | 56514 | 56526 | 56538 | 56549 | 56561 | 56573 |
| 368 | 56585 | 56597 | 56608 | 56620 | 56632 | 56644 | 56656 | 56667 | 56679 | 56691 |
| 369 | 56703 | 56714 | 56726 | 56738 | 56750 | 56761 | 56773 | 56785 | 56797 | 56808 |
| 370 | 56820 | 56832 | 56844 | 56855 | 56867 | 56879 | 56891 | 56902 | 56914 | 56926 |
| 371 | 56937 | 56949 | 56961 | 56972 | 56984 | 56996 | 57008 | 57019 | 57031 | 57043 |
| 372 | 57054 | 57066 | 57078 | 57089 | 57101 | 57113 | 57124 | 57136 | 57148 | 57159 |
| 373 | 57171 | 57183 | 57194 | 57206 | 57217 | 57229 | 57241 | 57252 | 57264 | 57276 |
| 374 | 57287 | 57299 | 57310 | 57322 | 57334 | 57345 | 57357 | 57368 | 57380 | 57392 |
| 375 | 57403 | 57415 | 57426 | 57438 | 57449 | 57461 | 57473 | 57484 | 57496 | 57507 |
| 376 | 57519 | 57530 | 57542 | 57553 | 57565 | 57576 | 57588 | 57600 | 57611 | 57623 |
| 377 | 57634 | 57646 | 57657 | 57669 | 57680 | 57692 | 57703 | 57715 | 57726 | 57738 |
| 378 | 57749 | 57761 | 57772 | 57784 | 57795 | 57807 | 57818 | 57830 | 57841 | 57852 |
| 379 | 57864 | 57875 | 57887 | 57898 | 57910 | 57921 | 57933 | 57944 | 57955 | 57967 |
| 380 | 57978 | 57990 | 58001 | 58013 | 58024 | 58035 | 58047 | 58058 | 58070 | 58081 |
| 381 | 58092 | 58104 | 58115 | 58127 | 58138 | 58149 | 58161 | 58172 | 58184 | 58195 |
| 382 | 58206 | 58218 | 58229 | 58240 | 58252 | 58263 | 58274 | 58286 | 58297 | 58309 |
| 383 | 58320 | 58331 | 58343 | 58354 | 58365 | 58377 | 58388 | 58399 | 58410 | 58422 |
| 384 | 58433 | 58444 | 58456 | 58467 | 58478 | 58490 | 58501 | 58512 | 58524 | 58535 |
| 385 | 58546 | 58557 | 58569 | 58580 | 58591 | 58602 | 58614 | 58625 | 58636 | 58647 |
| 386 | 58659 | 58670 | 58681 | 58692 | 58704 | 58715 | 58726 | 58737 | 58749 | 58760 |
| 387 | 58771 | 58782 | 58794 | 58805 | 58816 | 58827 | 58838 | 58850 | 58861 | 58872 |
| 388 | 58883 | 58894 | 58906 | 58917 | 58928 | 58939 | 58950 | 58961 | 58973 | 58984 |
| 389 | 58995 | 59006 | 59017 | 59028 | 59040 | 59051 | 59062 | 59073 | 59084 | 59095 |
| 390 | 59106 | 59118 | 59129 | 59140 | 59151 | 59162 | 59173 | 59184 | 59195 | 59207 |
| 391 | 59218 | 59229 | 59240 | 59251 | 59262 | 59273 | 59284 | 59295 | 59306 | 59318 |
| 392 | 59329 | 59340 | 59351 | 59362 | 59373 | 59384 | 59395 | 59406 | 59417 | 59428 |
| 393 | 59439 | 59450 | 59461 | 59472 | 59483 | 59494 | 59506 | 59517 | 59528 | 59539 |
| 394 | 59550 | 59561 | 59572 | 59583 | 59594 | 59605 | 59616 | 59627 | 59638 | 59649 |
| 395 | 59660 | 59671 | 59682 | 59693 | 59704 | 59715 | 59726 | 59737 | 59748 | 59759 |
| 396 | 59770 | 59780 | 59791 | 59802 | 59813 | 59824 | 59835 | 59846 | 59857 | 59868 |
| 397 | 59879 | 59890 | 59901 | 59912 | 59923 | 59934 | 59945 | 59956 | 59966 | 59977 |
| 398 | 59988 | 59999 | 60010 | 60021 | 60032 | 60043 | 60054 | 60065 | 60076 | 60086 |
| 399 | 60097 | 60108 | 60119 | 60130 | 60141 | 60152 | 60163 | 60173 | 60184 | 60195 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Proportional parts:

**13**

| | |
|---|---|
| 1 | 1 |
| 2 | 3 |
| 3 | 4 |
| 4 | 5 |
| 5 | 7 |
| 6 | 8 |
| 7 | 9 |
| 8 | 10 |
| 9 | 12 |

**12**

| | |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 5 |
| 5 | 6 |
| 6 | 7 |
| 7 | 8 |
| 8 | 10 |
| 9 | 11 |

**11**

| | |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 6 |
| 6 | 7 |
| 7 | 8 |
| 8 | 9 |
| 9 | 10 |

**10**

| | |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |

TABLE 42. [Page 597

Logarithms of Numbers.

No. 4000——4600.  Log. 60206——66276.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 11 |
| 400 | 60206 | 60217 | 60228 | 60239 | 60249 | 60260 | 60271 | 60282 | 60293 | 60304 | | |
| 401 | 60314 | 60325 | 60336 | 60347 | 60358 | 60369 | 60379 | 60390 | 60401 | 60412 | | |
| 402 | 60423 | 60433 | 60444 | 60455 | 60466 | 60477 | 60487 | 60498 | 60509 | 60520 | 1 | 1 |
| 403 | 60531 | 60541 | 60552 | 60563 | 60574 | 60584 | 60595 | 60606 | 60617 | 60627 | 2 | 2 |
| 404 | 60638 | 60649 | 60660 | 60670 | 60681 | 60692 | 60703 | 60713 | 60724 | 60735 | 3 | 3 |
| | | | | | | | | | | | 4 | 4 |
| 405 | 60746 | 60756 | 60767 | 60778 | 60788 | 60799 | 60810 | 60821 | 60831 | 60842 | 5 | 6 |
| 406 | 60853 | 60863 | 60874 | 60885 | 60895 | 60906 | 60917 | 60927 | 60938 | 60949 | 6 | 7 |
| 407 | 60959 | 60970 | 60981 | 60991 | 61002 | 61013 | 61023 | 61034 | 61045 | 61055 | 7 | 8 |
| 408 | 61066 | 61077 | 61087 | 61098 | 61109 | 61119 | 61130 | 61140 | 61151 | 61162 | 8 | 9 |
| 409 | 61172 | 61183 | 61194 | 61204 | 61215 | 61225 | 61236 | 61247 | 61257 | 61268 | 9 | 10 |
| 410 | 61278 | 61289 | 61300 | 61310 | 61321 | 61331 | 61342 | 61352 | 61363 | 61374 | | |
| 411 | 61384 | 61395 | 61405 | 61416 | 61426 | 61437 | 61448 | 61458 | 61469 | 61479 | | |
| 412 | 61490 | 61500 | 61511 | 61521 | 61532 | 61542 | 61553 | 61563 | 61574 | 61584 | | |
| 413 | 61595 | 61606 | 61616 | 61627 | 61637 | 61648 | 61658 | 61669 | 61679 | 61690 | | |
| 414 | 61700 | 61711 | 61721 | 61731 | 61742 | 61752 | 61763 | 61773 | 61784 | 61794 | | |
| 415 | 61805 | 61815 | 61826 | 61836 | 61847 | 61857 | 61868 | 61878 | 61888 | 61899 | | |
| 416 | 61909 | 61920 | 61930 | 61941 | 61951 | 61962 | 61972 | 61982 | 61993 | 62003 | | |
| 417 | 62014 | 62024 | 62034 | 62045 | 62055 | 62066 | 62076 | 62086 | 62097 | 62107 | | |
| 418 | 62118 | 62128 | 62138 | 62149 | 62159 | 62170 | 62180 | 62190 | 62201 | 62211 | | |
| 419 | 62221 | 62232 | 62242 | 62252 | 62263 | 62273 | 62284 | 62294 | 62304 | 62315 | | |
| 420 | 62325 | 62335 | 62346 | 62356 | 62366 | 62377 | 62387 | 62397 | 62408 | 62418 | | |
| 421 | 62428 | 62439 | 62449 | 62459 | 62469 | 62480 | 62490 | 62500 | 62511 | 62521 | | |
| 422 | 62531 | 62542 | 62552 | 62562 | 62572 | 62583 | 62593 | 62603 | 62613 | 62624 | | |
| 423 | 62634 | 62644 | 62655 | 62665 | 62675 | 62685 | 62696 | 62706 | 62716 | 62726 | | |
| 424 | 62737 | 62747 | 62757 | 62767 | 62778 | 62788 | 62798 | 62808 | 62818 | 62829 | | 10 |
| 425 | 62839 | 62849 | 62859 | 62870 | 62880 | 62890 | 62900 | 62910 | 62921 | 62931 | | |
| 426 | 62941 | 62951 | 62961 | 62972 | 62982 | 62992 | 63002 | 63012 | 63022 | 63033 | 1 | 1 |
| 427 | 63043 | 63053 | 63063 | 63073 | 63083 | 63094 | 63104 | 63114 | 63124 | 63134 | 2 | 2 |
| 428 | 63144 | 63155 | 63165 | 63175 | 63185 | 63195 | 63205 | 63215 | 63225 | 63236 | 3 | 3 |
| 429 | 63246 | 63256 | 63266 | 63276 | 63286 | 63296 | 63306 | 63317 | 63327 | 63337 | 4 | 4 |
| 430 | 63347 | 63357 | 63367 | 63377 | 63387 | 63397 | 63407 | 63417 | 63428 | 63438 | 5 | 5 |
| 431 | 63448 | 63458 | 63468 | 63478 | 63488 | 63498 | 63508 | 63518 | 63528 | 63538 | 6 | 6 |
| 432 | 63548 | 63558 | 63568 | 63579 | 63589 | 63599 | 63609 | 63619 | 63629 | 63639 | 7 | 7 |
| 433 | 63649 | 63659 | 63669 | 63679 | 63689 | 63699 | 63709 | 63719 | 63729 | 63739 | 8 | 8 |
| 434 | 63749 | 63759 | 63769 | 63779 | 63789 | 63799 | 63809 | 63819 | 63829 | 63839 | 9 | 9 |
| 435 | 63849 | 63859 | 63869 | 63879 | 63889 | 63899 | 63909 | 63919 | 63929 | 63939 | | |
| 436 | 63949 | 63959 | 63969 | 63979 | 63988 | 63998 | 64008 | 64018 | 64028 | 64038 | | |
| 437 | 64048 | 64058 | 64068 | 64078 | 64088 | 64098 | 64108 | 64118 | 64128 | 64137 | | |
| 438 | 64147 | 64157 | 64167 | 64177 | 64187 | 64197 | 64207 | 64217 | 64227 | 64237 | | |
| 439 | 64246 | 64256 | 64266 | 64276 | 64286 | 64296 | 64306 | 64316 | 64326 | 64335 | | |
| 440 | 64345 | 64355 | 64365 | 64375 | 64385 | 64395 | 64404 | 64414 | 64424 | 64434 | | |
| 441 | 64444 | 64454 | 64464 | 64473 | 64483 | 64493 | 64503 | 64513 | 64523 | 64532 | | |
| 442 | 64542 | 64552 | 64562 | 64572 | 64582 | 64591 | 64601 | 64611 | 64621 | 64631 | | |
| 443 | 64640 | 64650 | 64660 | 64670 | 64680 | 64689 | 64699 | 64709 | 64719 | 64729 | | |
| 444 | 64738 | 64748 | 64758 | 64768 | 64777 | 64787 | 64797 | 64807 | 64816 | 64826 | | |
| 445 | 64836 | 64846 | 64856 | 64865 | 64875 | 64885 | 64895 | 64904 | 64914 | 64924 | | |
| 446 | 64933 | 64943 | 64953 | 64963 | 64972 | 64982 | 64992 | 65002 | 65011 | 65021 | | |
| 447 | 65031 | 65040 | 65050 | 65060 | 65070 | 65079 | 65089 | 65099 | 65108 | 65118 | | |
| 448 | 65128 | 65137 | 65147 | 65157 | 65167 | 65176 | 65186 | 65196 | 65205 | 65215 | | |
| 449 | 65225 | 65234 | 65244 | 65254 | 65263 | 65273 | 65283 | 65292 | 65302 | 65312 | | 9 |
| 450 | 65321 | 65331 | 65341 | 65350 | 65360 | 65369 | 65379 | 65389 | 65398 | 65408 | | |
| 451 | 65418 | 65427 | 65437 | 65447 | 65456 | 65466 | 65475 | 65485 | 65495 | 65504 | 1 | 1 |
| 452 | 65514 | 65523 | 65533 | 65543 | 65552 | 65562 | 65571 | 65581 | 65591 | 65600 | 2 | 2 |
| 453 | 65610 | 65619 | 65629 | 65639 | 65648 | 65658 | 65667 | 65677 | 65686 | 65696 | 3 | 3 |
| 454 | 65706 | 65715 | 65725 | 65734 | 65744 | 65753 | 65763 | 65772 | 65782 | 65792 | 4 | 4 |
| 455 | 65801 | 65811 | 65820 | 65830 | 65839 | 65849 | 65858 | 65868 | 65877 | 65887 | 5 | 5 |
| 456 | 65896 | 65906 | 65916 | 65925 | 65935 | 65944 | 65954 | 65963 | 65973 | 65982 | 6 | 5 |
| 457 | 65992 | 66001 | 66011 | 66020 | 66030 | 66039 | 66049 | 66058 | 66068 | 66077 | 7 | 6 |
| 458 | 66087 | 66096 | 66106 | 66115 | 66124 | 66134 | 66143 | 66153 | 66162 | 66172 | 8 | 7 |
| 459 | 66181 | 66191 | 66200 | 66210 | 66219 | 66229 | 66238 | 66247 | 66257 | 66266 | 9 | 8 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |

# TABLE 42.

### Logarithms of Numbers.

No. 4600——5200.                                                                 Log. 66276——71600.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 10 |
| 460 | 66276 | 66285 | 66295 | 66304 | 66314 | 66323 | 66332 | 66342 | 66351 | 66361 | | |
| 461 | 66370 | 66380 | 66389 | 66398 | 66408 | 66417 | 66427 | 66436 | 66445 | 66455 | | |
| 462 | 66464 | 66474 | 66483 | 66492 | 66502 | 66511 | 66521 | 66530 | 66539 | 66549 | 1 | 1 |
| 463 | 66558 | 66567 | 66577 | 66586 | 66596 | 66605 | 66614 | 66624 | 66633 | 66642 | 2 | 2 |
| 464 | 66652 | 66661 | 66671 | 66680 | 66689 | 66699 | 66708 | 66717 | 66727 | 66736 | 3 | 3 |
| 465 | 66745 | 66755 | 66764 | 66773 | 66783 | 66792 | 66801 | 66811 | 66820 | 66829 | 4 | 4 |
| 466 | 66839 | 66848 | 66857 | 66867 | 66876 | 66885 | 66894 | 66904 | 66913 | 66922 | 5 | 5 |
| 467 | 66932 | 66941 | 66950 | 66960 | 66969 | 66978 | 66987 | 66997 | 67006 | 67015 | 6 | 6 |
| 468 | 67025 | 67034 | 67043 | 67052 | 67062 | 67071 | 67080 | 67089 | 67099 | 67108 | 7 | 7 |
| 469 | 67117 | 67127 | 67136 | 67145 | 67154 | 67164 | 67173 | 67182 | 67191 | 67201 | 8 | 8 |
| 470 | 67210 | 67219 | 67228 | 67237 | 67247 | 67256 | 67265 | 67274 | 67284 | 67293 | 9 | 9 |
| 471 | 67302 | 67311 | 67321 | 67330 | 67339 | 67348 | 67357 | 67367 | 67376 | 67385 | | |
| 472 | 67394 | 67403 | 67413 | 67422 | 67431 | 67440 | 67449 | 67459 | 67468 | 67477 | | |
| 473 | 67486 | 67495 | 67504 | 67514 | 67523 | 67532 | 67541 | 67550 | 67560 | 67569 | | |
| 474 | 67578 | 67587 | 67596 | 67605 | 67614 | 67624 | 67633 | 67642 | 67651 | 67660 | | |
| 475 | 67669 | 67679 | 67688 | 67697 | 67706 | 67715 | 67724 | 67733 | 67742 | 67752 | | |
| 476 | 67761 | 67770 | 67779 | 67788 | 67797 | 67806 | 67815 | 67825 | 67834 | 67843 | | |
| 477 | 67852 | 67861 | 67870 | 67879 | 67888 | 67897 | 67906 | 67916 | 67925 | 67934 | | |
| 478 | 67943 | 67952 | 67961 | 67970 | 67979 | 67988 | 67997 | 68006 | 68015 | 68024 | | |
| 479 | 68034 | 68043 | 68052 | 68061 | 68070 | 68079 | 68088 | 68097 | 68106 | 68115 | | |
| 480 | 68124 | 68133 | 68142 | 68151 | 68160 | 68169 | 68178 | 68187 | 68196 | 68205 | | |
| 481 | 68215 | 68224 | 68233 | 68242 | 68251 | 68260 | 68269 | 68278 | 68287 | 68296 | | |
| 482 | 68305 | 68314 | 68323 | 68332 | 68341 | 68350 | 68359 | 68368 | 68377 | 68386 | | |
| 483 | 68395 | 68404 | 68413 | 68422 | 68431 | 68440 | 68449 | 68458 | 68467 | 68476 | | |
| 484 | 68485 | 68494 | 68502 | 68511 | 68520 | 68529 | 68538 | 68547 | 68556 | 68565 | | 9 |
| 485 | 68574 | 68583 | 68592 | 68601 | 68610 | 68619 | 68628 | 68637 | 68646 | 68655 | | |
| 486 | 68664 | 68673 | 68681 | 68690 | 68699 | 68708 | 68717 | 68726 | 68735 | 68744 | 1 | 1 |
| 487 | 68753 | 68762 | 68771 | 68780 | 68789 | 68797 | 68806 | 68815 | 68824 | 68833 | 2 | 2 |
| 488 | 68842 | 68851 | 68860 | 68869 | 68878 | 68886 | 68895 | 68904 | 68913 | 68922 | 3 | 3 |
| 489 | 68931 | 68940 | 68949 | 68958 | 68966 | 68975 | 68984 | 68993 | 69002 | 69011 | 4 | 4 |
| 490 | 69020 | 69028 | 69037 | 69046 | 69055 | 69064 | 69073 | 69082 | 69090 | 69099 | 5 | 5 |
| 491 | 69108 | 69117 | 69126 | 69135 | 69144 | 69152 | 69161 | 69170 | 69179 | 69188 | 6 | 5 |
| 492 | 69197 | 69205 | 69214 | 69223 | 69232 | 69241 | 69249 | 69258 | 69267 | 69276 | 7 | 6 |
| 493 | 69285 | 69294 | 69302 | 69311 | 69320 | 69329 | 69338 | 69346 | 69355 | 69364 | 8 | 7 |
| 494 | 69373 | 69381 | 69390 | 69399 | 69408 | 69417 | 69425 | 69434 | 69443 | 69452 | 9 | 8 |
| 495 | 69461 | 69469 | 69478 | 69487 | 69496 | 69504 | 69513 | 69522 | 69531 | 69539 | | |
| 496 | 69548 | 69557 | 69566 | 69574 | 69583 | 69592 | 69601 | 69609 | 69618 | 69627 | | |
| 497 | 69636 | 69644 | 69653 | 69662 | 69671 | 69679 | 69688 | 69697 | 69705 | 69714 | | |
| 498 | 69723 | 69732 | 69740 | 69749 | 69758 | 69767 | 69775 | 69784 | 69793 | 69801 | | |
| 499 | 69810 | 69819 | 69827 | 69836 | 69845 | 69854 | 69862 | 69871 | 69880 | 69888 | | |
| 500 | 69897 | 69906 | 69914 | 69923 | 69932 | 69940 | 69949 | 69958 | 69966 | 69975 | | |
| 501 | 69984 | 69992 | 70001 | 70010 | 70018 | 70027 | 70036 | 70044 | 70053 | 70062 | | |
| 502 | 70070 | 70079 | 70088 | 70096 | 70105 | 70114 | 70122 | 70131 | 70140 | 70148 | | |
| 503 | 70157 | 70165 | 70174 | 70183 | 70191 | 70200 | 70209 | 70217 | 70226 | 70234 | | |
| 504 | 70243 | 70252 | 70260 | 70269 | 70278 | 70286 | 70295 | 70303 | 70312 | 70321 | | |
| 505 | 70329 | 70338 | 70346 | 70355 | 70364 | 70372 | 70381 | 70389 | 70398 | 70406 | | |
| 506 | 70415 | 70424 | 70432 | 70441 | 70449 | 70458 | 70467 | 70475 | 70484 | 70492 | | |
| 507 | 70501 | 70509 | 70518 | 70526 | 70535 | 70544 | 70552 | 70561 | 70569 | 70578 | | |
| 508 | 70586 | 70595 | 70603 | 70612 | 70621 | 70629 | 70638 | 70646 | 70655 | 70663 | | |
| 509 | 70672 | 70680 | 70689 | 70697 | 70706 | 70714 | 70723 | 70731 | 70740 | 70749 | | 8 |
| 510 | 70757 | 70766 | 70774 | 70783 | 70791 | 70800 | 70808 | 70817 | 70825 | 70834 | | |
| 511 | 70842 | 70851 | 70859 | 70868 | 70876 | 70885 | 70893 | 70902 | 70910 | 70919 | 1 | 1 |
| 512 | 70927 | 70935 | 70944 | 70952 | 70961 | 70969 | 70978 | 70986 | 70995 | 71003 | 2 | 2 |
| 513 | 71012 | 71020 | 71029 | 71037 | 71046 | 71054 | 71063 | 71071 | 71079 | 71088 | 3 | 2 |
| 514 | 71096 | 71105 | 71113 | 71122 | 71130 | 71139 | 71147 | 71155 | 71164 | 71172 | 4 | 3 |
| 515 | 71181 | 71189 | 71198 | 71206 | 71214 | 71223 | 71231 | 71240 | 71248 | 71257 | 5 | 4 |
| 516 | 71265 | 71273 | 71282 | 71290 | 71299 | 71307 | 71315 | 71324 | 71332 | 71341 | 6 | 5 |
| 517 | 71349 | 71357 | 71366 | 71374 | 71383 | 71391 | 71399 | 71408 | 71416 | 71425 | 7 | 6 |
| 518 | 71433 | 71441 | 71450 | 71458 | 71466 | 71475 | 71483 | 71492 | 71500 | 71508 | 8 | 6 |
| 519 | 71517 | 71525 | 71533 | 71542 | 71550 | 71559 | 71567 | 71575 | 71584 | 71592 | 9 | 7 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |

TABLE 42.

[Page 599

Logarithms of Numbers.

No. 5200——5800.                                                        Log. 71600——76343.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 520 | 71600 | 71609 | 71617 | 71625 | 71634 | 71642 | 71650 | 71659 | 71667 | 71675 | | **9** |
| 521 | 71684 | 71692 | 71700 | 71709 | 71717 | 71725 | 71734 | 71742 | 71750 | 71759 | | |
| 522 | 71767 | 71775 | 71784 | 71792 | 71800 | 71809 | 71817 | 71825 | 71834 | 71842 | 1 | 1 |
| 523 | 71850 | 71858 | 71867 | 71875 | 71883 | 71892 | 71900 | 71908 | 71917 | 71925 | 2 | 2 |
| 524 | 71933 | 71941 | 71950 | 71958 | 71966 | 71975 | 71983 | 71991 | 71999 | 72008 | 3 | 3 |
| 525 | 72016 | 72024 | 72032 | 72041 | 72049 | 72057 | 72066 | 72074 | 72082 | 72090 | 4 | 4 |
| 526 | 72099 | 72107 | 72115 | 72123 | 72132 | 72140 | 72148 | 72156 | 72165 | 72173 | 5 | 5 |
| 527 | 72181 | 72189 | 72198 | 72206 | 72214 | 72222 | 72230 | 72239 | 72247 | 72255 | 6 | 5 |
| 528 | 72263 | 72272 | 72280 | 72288 | 72296 | 72304 | 72313 | 72321 | 72329 | 72337 | 7 | 6 |
| 529 | 72346 | 72354 | 72362 | 72370 | 72378 | 72387 | 72395 | 72403 | 72411 | 72419 | 8 | 7 |
| | | | | | | | | | | | 9 | 8 |
| 530 | 72428 | 72436 | 72444 | 72452 | 72460 | 72469 | 72477 | 72485 | 72493 | 72501 | | |
| 531 | 72509 | 72518 | 72526 | 72534 | 72542 | 72550 | 72558 | 72567 | 72575 | 72583 | | |
| 532 | 72591 | 72599 | 72607 | 72616 | 72624 | 72632 | 72640 | 72648 | 72656 | 72665 | | |
| 533 | 72673 | 72681 | 72689 | 72697 | 72705 | 72713 | 72722 | 72730 | 72738 | 72746 | | |
| 534 | .72754 | 72762 | 72770 | 72779 | 72787 | 72795 | 72803 | 72811 | 72819 | 72827 | | |
| 535 | 72835 | 72843 | 72852 | 72860 | 72868 | 72876 | 72884 | 72892 | 72900 | 72908 | | |
| 536 | 72916 | 72925 | 72933 | 72941 | 72949 | 72957 | 72965 | 72973 | 72981 | 72989 | | |
| 537 | 72997 | 73006 | 73014 | 73022 | 73030 | 73038 | 73046 | 73054 | 73062 | 73070 | | |
| 538 | 73078 | 73086 | 73094 | 73102 | 73111 | 73119 | 73127 | 73135 | 73143 | 73151 | | |
| 539 | 73159 | 73167 | 73175 | 73183 | 73191 | 73199 | 73207 | 73215 | 73223 | 73231 | | |
| 540 | 73239 | 73247 | 73255 | 73263 | 73272 | 73280 | 73288 | 73296 | 73304 | 73312 | | |
| 541 | 73320 | 73328 | 73336 | 73344 | 73352 | 73360 | 73368 | 73376 | 73384 | 73392 | | |
| 542 | 73400 | 73408 | 73416 | 73424 | 73432 | 73440 | 73448 | 73456 | 73464 | 73472 | | |
| 543 | 73480 | 73488 | 73496 | 73504 | 73512 | 73520 | 73528 | 73536 | 73544 | 73552 | | |
| 544 | 73560 | 73568 | 73576 | 73584 | 73592 | 73600 | 73608 | 73616 | 73624 | 73632 | | **8** |
| 545 | 73640 | 73648 | 73656 | 73664 | 73672 | 73679 | 73687 | 73695 | 73703 | 73711 | | |
| 546 | 73719 | 73727 | 73735 | 73743 | 73751 | 73759 | 73767 | 73775 | 73783 | 73791 | 1 | 1 |
| 547 | 73799 | 73807 | 73815 | 73823 | 73830 | 73838 | 73846 | 73854 | 73862 | 73870 | 2 | 2 |
| 548 | 73878 | 73886 | 73894 | 73902 | 73910 | 73918 | 73926 | 73933 | 73941 | 73949 | 3 | 2 |
| 549 | 73957 | 73965 | 73973 | 73981 | 73989 | 73997 | 74005 | 74013 | 74020 | 74028 | 4 | 3 |
| 550 | 74036 | 74044 | 74052 | 74060 | 74068 | 74076 | 74084 | 74092 | 74099 | 74107 | 5 | 4 |
| 551 | 74115 | 74123 | 74131 | 74139 | 74147 | 74155 | 74162 | 74170 | 74178 | 74186 | 6 | 5 |
| 552 | 74194 | 74202 | 74210 | 74218 | 74225 | 74233 | 74241 | 74249 | 74257 | 74265 | 7 | 6 |
| 553 | 74273 | 74280 | 74288 | 74296 | 74304 | 74312 | 74320 | 74327 | 74335 | 74343 | 8 | 6 |
| 554 | 74351 | 74359 | 74367 | 74374 | 74382 | 74390 | 74398 | 74406 | 74414 | 74421 | 9 | 7 |
| 555 | 74429 | 74437 | 74445 | 74453 | 74461 | 74468 | 74476 | 74484 | 74492 | 74500 | | |
| 556 | 74507 | 74515 | 74523 | 74531 | 74539 | 74547 | 74554 | 74562 | 74570 | 74578 | | |
| 557 | 74586 | 74593 | 74601 | 74609 | 74617 | 74624 | 74632 | 74640 | 74648 | 74656 | | |
| 558 | 74663 | 74671 | 74679 | 74687 | 74695 | 74702 | 74710 | 74718 | 74726 | 74733 | | |
| 559 | 74741 | 74749 | 74757 | 74764 | 74772 | 74780 | 74788 | 74796 | 74803 | 74811 | | |
| 560 | 74819 | 74827 | 74834 | 74842 | 74850 | 74858 | 74865 | 74873 | 74881 | 74889 | | |
| 561 | 74896 | 74904 | 74912 | 74920 | 74927 | 74935 | 74943 | 74950 | 74958 | 74966 | | |
| 562 | 74974 | 74981 | 74989 | 74997 | 75005 | 75012 | 75020 | 75028 | 75035 | 75043 | | |
| 563 | 75051 | 75059 | 75066 | 75074 | 75082 | 75089 | 75097 | 75105 | 75113 | 75120 | | |
| 564 | 75128 | 75136 | 75143 | 75151 | 75159 | 75166 | 75174 | 75182 | 75189 | 75197 | | |
| 565 | 75205 | 75213 | 75220 | 75228 | 75236 | 75243 | 75251 | 75259 | 75266 | 75274 | | |
| 566 | 75282 | 75289 | 75297 | 75305 | 75312 | 75320 | 75328 | 75335 | 75343 | 75351 | | |
| 567 | 75358 | 75366 | 75374 | 75381 | 75389 | 75397 | 75404 | 75412 | 75420 | 75427 | | |
| 568 | 75435 | 75442 | 75450 | 75458 | 75465 | 75473 | 75481 | 75488 | 75496 | 75504 | | |
| 569 | 75511 | 75519 | 75526 | 75534 | 75542 | 75549 | 75557 | 75565 | 75572 | 75580 | | **7** |
| 570 | 75587 | 75595 | 75603 | 75610 | 75618 | 75626 | 75633 | 75641 | 75648 | 75656 | | |
| 571 | 75664 | 75671 | 75679 | 75686 | 75694 | 75702 | 75709 | 75717 | 75724 | 75732 | 1 | 1 |
| 572 | 75740 | 75747 | 75755 | 75762 | 75770 | 75778 | 75785 | 75793 | 75800 | 75808 | 2 | 1 |
| 573 | 75815 | 75823 | 75831 | 75838 | 75846 | 75853 | 75861 | 75868 | 75876 | 75884 | 3 | 2 |
| 574 | 75891 | 75899 | 75906 | 75914 | 75921 | 75929 | 75937 | 75944 | 75952 | 75959 | 4 | 3 |
| 575 | 75967 | 75974 | 75982 | 75989 | 75997 | 76005 | 76012 | 76020 | 76027 | 76035 | 5 | 4 |
| 576 | 76042 | 76050 | 76057 | 76065 | 76072 | 76080 | 76087 | 76095 | 76103 | 76110 | 6 | 4 |
| 577 | 76118 | 76125 | 76133 | 76140 | 76148 | 76155 | 76163 | 76170 | 76178 | 76185 | 7 | 5 |
| 578 | 76193 | 76200 | 76208 | 76215 | 76223 | 76230 | 76238 | 76245 | 76253 | 76260 | 8 | 6 |
| 579 | 76268 | 76275 | 76283 | 76290 | 76298 | 76305 | 76313 | 76320 | 76328 | 76335 | 9 | 6 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |

# TABLE 42.

### Logarithms of Numbers.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|---|
| | | | | | | | | | | | | **8** |
| 580 | 76343 | 76350 | 76358 | 76365 | 76373 | 76380 | 76388 | 76395 | 76403 | 76410 | | |
| 581 | 76418 | 76425 | 76433 | 76440 | 76448 | 76455 | 76462 | 76470 | 76477 | 76485 | | |
| 582 | 76492 | 76500 | 76507 | 76515 | 76522 | 76530 | 76537 | 76545 | 76552 | 76559 | 1 | 1 |
| 583 | 76567 | 76574 | 76582 | 76589 | 76597 | 76604 | 76612 | 76619 | 76626 | 76634 | 2 | 2 |
| 584 | 76641 | 76649 | 76656 | 76664 | 76671 | 76678 | 76686 | 76693 | 76701 | 76708 | 3 | 2 |
| 585 | 76716 | 76723 | 76730 | 76738 | 76745 | 76753 | 76760 | 76768 | 76775 | 76782 | 4 | 3 |
| 586 | 76790 | 76797 | 76805 | 76812 | 76819 | 76827 | 76834 | 76842 | 76849 | 76856 | 5 | 4 |
| 587 | 76864 | 76871 | 76879 | 76886 | 76893 | 76901 | 76908 | 76916 | 76923 | 76930 | 6 | 5 |
| 588 | 76938 | 76945 | 76953 | 76960 | 76967 | 76975 | 76982 | 76989 | 76997 | 77004 | 7 | 6 |
| 589 | 77012 | 77019 | 77026 | 77034 | 77041 | 77048 | 77056 | 77063 | 77070 | 77078 | 8 | 6 |
| | | | | | | | | | | | 9 | 7 |
| 590 | 77085 | 77093 | 77100 | 77107 | 77115 | 77122 | 77129 | 77137 | 77144 | 77151 | | |
| 591 | 77159 | 77166 | 77173 | 77181 | 77188 | 77195 | 77203 | 77210 | 77217 | 77225 | | |
| 592 | 77232 | 77240 | 77247 | 77254 | 77262 | 77269 | 77276 | 77283 | 77291 | 77298 | | |
| 593 | 77305 | 77313 | 77320 | 77327 | 77335 | 77342 | 77349 | 77357 | 77364 | 77371 | | |
| 594 | 77379 | 77386 | 77393 | 77401 | 77408 | 77415 | 77422 | 77430 | 77437 | 77444 | | |
| 595 | 77452 | 77459 | 77466 | 77474 | 77481 | 77488 | 77495 | 77503 | 77510 | 77517 | | |
| 596 | 77525 | 77532 | 77539 | 77546 | 77554 | 77561 | 77568 | 77576 | 77583 | 77590 | | |
| 597 | 77597 | 77605 | 77612 | 77619 | 77627 | 77634 | 77641 | 77648 | 77656 | 77663 | | |
| 598 | 77670 | 77677 | 77685 | 77692 | 77699 | 77706 | 77714 | 77721 | 77728 | 77735 | | |
| 599 | 77743 | 77750 | 77757 | 77764 | 77772 | 77779 | 77786 | 77793 | 77801 | 77808 | | |
| 600 | 77815 | 77822 | 77830 | 77837 | 77844 | 77851 | 77859 | 77866 | 77873 | 77880 | | |
| 601 | 77887 | 77895 | 77902 | 77909 | 77916 | 77924 | 77931 | 77938 | 77945 | 77952 | | |
| 602 | 77960 | 77967 | 77974 | 77981 | 77988 | 77996 | 78003 | 78010 | 78017 | 78025 | | |
| 603 | 78032 | 78039 | 78046 | 78053 | 78061 | 78068 | 78075 | 78082 | 78089 | 78097 | | |
| 604 | 78104 | 78111 | 78118 | 78125 | 78132 | 78140 | 78147 | 78154 | 78161 | 78168 | | |
| | | | | | | | | | | | | **7** |
| 605 | 78176 | 78183 | 78190 | 78197 | 78204 | 78211 | 78219 | 78226 | 78233 | 78240 | | |
| 606 | 78247 | 78254 | 78262 | 78269 | 78276 | 78283 | 78290 | 78297 | 78305 | 78312 | | |
| 607 | 78319 | 78326 | 78333 | 78340 | 78347 | 78355 | 78362 | 78369 | 78376 | 78383 | 1 | 1 |
| 608 | 78390 | 78398 | 78405 | 78412 | 78419 | 78426 | 78433 | 78440 | 78447 | 78455 | 2 | 1 |
| 609 | 78462 | 78469 | 78476 | 78483 | 78490 | 78497 | 78504 | 78512 | 78519 | 78526 | 3 | 2 |
| 610 | 78533 | 78540 | 78547 | 78554 | 78561 | 78569 | 78576 | 78583 | 78590 | 78597 | 4 | 3 |
| 611 | 78604 | 78611 | 78618 | 78625 | 78633 | 78640 | 78647 | 78654 | 78661 | 78668 | 5 | 4 |
| 612 | 78675 | 78682 | 78689 | 78696 | 78704 | 78711 | 78718 | 78725 | 78732 | 78739 | 6 | 4 |
| 613 | 78746 | 78753 | 78760 | 78767 | 78774 | 78781 | 78789 | 78796 | 78803 | 78810 | 7 | 5 |
| 614 | 78817 | 78824 | 78831 | 78838 | 78845 | 78852 | 78859 | 78866 | 78873 | 78880 | 8 | 6 |
| | | | | | | | | | | | 9 | 6 |
| 615 | 78888 | 78895 | 78902 | 78909 | 78916 | 78923 | 78930 | 78937 | 78944 | 78951 | | |
| 616 | 78958 | 78965 | 78972 | 78979 | 78986 | 78993 | 79000 | 79007 | 79014 | 79021 | | |
| 617 | 79029 | 79036 | 79043 | 79050 | 79057 | 79064 | 79071 | 79078 | 79085 | 79092 | | |
| 618 | 79099 | 79106 | 79113 | 79120 | 79127 | 79134 | 79141 | 79148 | 79155 | 79162 | | |
| 619 | 79169 | 79176 | 79183 | 79190 | 79197 | 79204 | 79211 | 79218 | 79225 | 79232 | | |
| 620 | 79239 | 79246 | 79253 | 79260 | 79267 | 79274 | 79281 | 79288 | 79295 | 79302 | | |
| 621 | 79309 | 79316 | 79323 | 79330 | 79337 | 79344 | 79351 | 79358 | 79365 | 79372 | | |
| 622 | 79379 | 79386 | 79393 | 79400 | 79407 | 79414 | 79421 | 79428 | 79435 | 79442 | | |
| 623 | 79449 | 79456 | 79463 | 79470 | 79477 | 79484 | 79491 | 79498 | 79505 | 79511 | | |
| 624 | 79518 | 79525 | 79532 | 79539 | 79546 | 79553 | 79560 | 79567 | 79574 | 79581 | | |
| 625 | 79588 | 79595 | 79602 | 79609 | 79616 | 79623 | 79630 | 79637 | 79644 | 79650 | | |
| 626 | 79657 | 79664 | 79671 | 79678 | 79685 | 79692 | 79699 | 79706 | 79713 | 79720 | | |
| 627 | 79727 | 79734 | 79741 | 79748 | 79754 | 79761 | 79768 | 79775 | 79782 | 79789 | | |
| 628 | 79796 | 79803 | 79810 | 79817 | 79824 | 79831 | 79837 | 79844 | 79851 | 79858 | | |
| 629 | 79865 | 79872 | 79879 | 79886 | 79893 | 79900 | 79906 | 79913 | 79920 | 79927 | | **6** |
| 630 | 79934 | 79941 | 79948 | 79955 | 79962 | 79969 | 79975 | 79982 | 79989 | 79996 | | |
| 631 | 80003 | 80010 | 80017 | 80024 | 80030 | 80037 | 80044 | 80051 | 80058 | 80065 | 1 | 1 |
| 632 | 80072 | 80079 | 80085 | 80092 | 80099 | 80106 | 80113 | 80120 | 80127 | 80134 | 2 | 1 |
| 633 | 80140 | 80147 | 80154 | 80161 | 80168 | 80175 | 80182 | 80188 | 80195 | 80202 | 3 | 2 |
| 634 | 80209 | 80216 | 80223 | 80229 | 80236 | 80243 | 80250 | 80257 | 80264 | 80271 | 4 | 2 |
| 635 | 80277 | 80284 | 80291 | 80298 | 80305 | 80312 | 80318 | 80325 | 80332 | 80339 | 5 | 3 |
| 636 | 80346 | 80353 | 80359 | 80366 | 80373 | 80380 | 80387 | 80393 | 80400 | 80407 | 6 | 4 |
| 637 | 80414 | 80421 | 80428 | 80434 | 80441 | 80448 | 80455 | 80462 | 80468 | 80475 | 7 | 4 |
| 638 | 80482 | 80489 | 80496 | 80502 | 80509 | 80516 | 80523 | 80530 | 80536 | 80543 | 8 | 5 |
| 639 | 80550 | 80557 | 80564 | 80570 | 80577 | 80584 | 80591 | 80598 | 80604 | 80611 | 9 | 5 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |

TABLE 42.

[Page 601

Logarithms of Numbers.

No. 6400——7000.                                                  Log. 80618——84510.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 640 | 80618 | 80625 | 80632 | 80638 | 80645 | 80652 | 80659 | 80665 | 80672 | 80679 |
| 641 | 80686 | 80693 | 80699 | 80706 | 80713 | 80720 | 80726 | 80733 | 80740 | 80747 |
| 642 | 80754 | 80760 | 80767 | 80774 | 80781 | 80787 | 80794 | 80801 | 80808 | 80814 |
| 643 | 80821 | 80828 | 80835 | 80841 | 80848 | 80855 | 80862 | 80868 | 80875 | 80882 |
| 644 | 80889 | 80895 | 80902 | 80909 | 80916 | 80922 | 80929 | 80936 | 80943 | 80949 |
| 645 | 80956 | 80963 | 80969 | 80976 | 80983 | 80990 | 80996 | 81003 | 81010 | 81017 |
| 646 | 81023 | 81030 | 81037 | 81043 | 81050 | 81057 | 81064 | 81070 | 81077 | 81084 |
| 647 | 81090 | 81097 | 81104 | 81111 | 81117 | 81124 | 81131 | 81137 | 81144 | 81151 |
| 648 | 81158 | 81164 | 81171 | 81178 | 81184 | 81191 | 81198 | 81204 | 81211 | 81218 |
| 649 | 81224 | 81231 | 81238 | 81245 | 81251 | 81258 | 81265 | 81271 | 81278 | 81285 |
| 650 | 81291 | 81298 | 81305 | 81311 | 81318 | 81325 | 81331 | 81338 | 81345 | 81351 |
| 651 | 81358 | 81365 | 81371 | 81378 | 81385 | 81391 | 81398 | 81405 | 81411 | 81418 |
| 652 | 81425 | 81431 | 81438 | 81445 | 81451 | 81458 | 81465 | 81471 | 81478 | 81485 |
| 653 | 81491 | 81498 | 81505 | 81511 | 81518 | 81525 | 81531 | 81538 | 81544 | 81551 |
| 654 | 81558 | 81564 | 81571 | 81578 | 81584 | 81591 | 81598 | 81604 | 81611 | 81617 |
| 655 | 81624 | 81631 | 81637 | 81644 | 81651 | 81657 | 81664 | 81671 | 81677 | 81684 |
| 656 | 81690 | 81697 | 81704 | 81710 | 81717 | 81723 | 81730 | 81737 | 81743 | 81750 |
| 657 | 81757 | 81763 | 81770 | 81776 | 81783 | 81790 | 81796 | 81803 | 81809 | 81816 |
| 658 | 81823 | 81829 | 81836 | 81842 | 81849 | 81856 | 81862 | 81869 | 81875 | 81882 |
| 659 | 81889 | 81895 | 81902 | 81908 | 81915 | 81921 | 81928 | 81935 | 81941 | 81948 |
| 660 | 81954 | 81961 | 81968 | 81974 | 81981 | 81987 | 81994 | 82000 | 82007 | 82014 |
| 661 | 82020 | 82027 | 82033 | 82040 | 82046 | 82053 | 82060 | 82066 | 82073 | 82079 |
| 662 | 82086 | 82092 | 82099 | 82105 | 82112 | 82119 | 82125 | 82132 | 82138 | 82145 |
| 663 | 82151 | 82158 | 82164 | 82171 | 82178 | 82184 | 82191 | 82197 | 82204 | 82210 |
| 664 | 82217 | 82223 | 82230 | 82236 | 82243 | 82249 | 82256 | 82263 | 82269 | 82276 |
| 665 | 82282 | 82289 | 82295 | 82302 | 82308 | 82315 | 82321 | 82328 | 82334 | 82341 |
| 666 | 82347 | 82354 | 82360 | 82367 | 82373 | 82380 | 82387 | 82393 | 82400 | 82406 |
| 667 | 82413 | 82419 | 82426 | 82432 | 82439 | 82445 | 82452 | 82458 | 82465 | 82471 |
| 668 | 82478 | 82484 | 82491 | 82497 | 82504 | 82510 | 82517 | 82523 | 82530 | 82536 |
| 669 | 82543 | 82549 | 82556 | 82562 | 82569 | 82575 | 82582 | 82588 | 82595 | 82601 |
| 670 | 82607 | 82614 | 82620 | 82627 | 82633 | 82640 | 82646 | 82653 | 82659 | 82666 |
| 671 | 82672 | 82679 | 82685 | 82692 | 82698 | 82705 | 82711 | 82718 | 82724 | 82730 |
| 672 | 82737 | 82743 | 82750 | 82756 | 82763 | 82769 | 82776 | 82782 | 82789 | 82795 |
| 673 | 82802 | 82808 | 82814 | 82821 | 82827 | 82834 | 82840 | 82847 | 82853 | 82860 |
| 674 | 82866 | 82872 | 82879 | 82885 | 82892 | 82898 | 82905 | 82911 | 82918 | 82924 |
| 675 | 82930 | 82937 | 82943 | 82950 | 82956 | 82963 | 82969 | 82975 | 82982 | 82988 |
| 676 | 82995 | 83001 | 83008 | 83014 | 83020 | 83027 | 83033 | 83040 | 83046 | 83052 |
| 677 | 83059 | 83065 | 83072 | 83078 | 83085 | 83091 | 83097 | 83104 | 83110 | 83117 |
| 678 | 83123 | 83129 | 83136 | 83142 | 83149 | 83155 | 83161 | 83168 | 83174 | 83181 |
| 679 | 83187 | 83193 | 83200 | 83206 | 83213 | 83219 | 83225 | 83232 | 83238 | 83245 |
| 680 | 83251 | 83257 | 83264 | 83270 | 83276 | 83283 | 83289 | 83296 | 83302 | 83308 |
| 681 | 83315 | 83321 | 83327 | 83334 | 83340 | 83347 | 83353 | 83359 | 83366 | 83372 |
| 682 | 83378 | 83385 | 83391 | 83398 | 83404 | 83410 | 83417 | 83423 | 83429 | 83436 |
| 683 | 83442 | 83448 | 83455 | 83461 | 83467 | 83474 | 83480 | 83487 | 83493 | 83499 |
| 684 | 83506 | 83512 | 83518 | 83525 | 83531 | 83537 | 83544 | 83550 | 83556 | 83563 |
| 685 | 83569 | 83575 | 83582 | 83588 | 83594 | 83601 | 83607 | 83613 | 83620 | 83626 |
| 686 | 83632 | 83639 | 83645 | 83651 | 83658 | 83664 | 83670 | 83677 | 83683 | 83689 |
| 687 | 83696 | 83702 | 83708 | 83715 | 83721 | 83727 | 83734 | 83740 | 83746 | 83753 |
| 688 | 83759 | 83765 | 83771 | 83778 | 83784 | 83790 | 83797 | 83803 | 83809 | 83816 |
| 689 | 83822 | 83828 | 83835 | 83841 | 83847 | 83853 | 83860 | 83866 | 83872 | 83879 |
| 690 | 83885 | 83891 | 83897 | 83904 | 83910 | 83916 | 83923 | 83929 | 83935 | 83942 |
| 691 | 83948 | 83954 | 83960 | 83967 | 83973 | 83979 | 83985 | 83992 | 83998 | 84004 |
| 692 | 84011 | 84017 | 84023 | 84029 | 84036 | 84042 | 84048 | 84055 | 84061 | 84067 |
| 693 | 84073 | 84080 | 84086 | 84092 | 84098 | 84105 | 84111 | 84117 | 84123 | 84130 |
| 694 | 84136 | 84142 | 84148 | 84155 | 84161 | 84167 | 84173 | 84180 | 84186 | 84192 |
| 695 | 84198 | 84205 | 84211 | 84217 | 84223 | 84230 | 84236 | 84242 | 84248 | 84255 |
| 696 | 84261 | 84267 | 84273 | 84280 | 84286 | 84292 | 84298 | 84305 | 84311 | 84317 |
| 697 | 84323 | 84330 | 84336 | 84342 | 84348 | 84354 | 84361 | 84367 | 84373 | 84379 |
| 698 | 84386 | 84392 | 84398 | 84404 | 84410 | 84417 | 84423 | 84429 | 84435 | 84442 |
| 699 | 84448 | 84454 | 84460 | 84466 | 84473 | 84479 | 84485 | 84491 | 84497 | 84504 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Proportional parts:

7
1 1
2 1
3 2
4 3
5 4
6 4
7 5
8 6
9 6

6
1 1
2 1
3 2
4 2
5 3
6 4
7 4
8 5
9 5

# TABLE 42.

### Logarithms of Numbers.

No. 7000——7600.                                             Log. 84510——88081.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 700 | 84510 | 84516 | 84522 | 84528 | 84535 | 84541 | 84547 | 84553 | 84559 | 84566 |
| 701 | 84572 | 84578 | 84584 | 84590 | 84597 | 84603 | 84609 | 84615 | 84621 | 84628 |
| 702 | 84634 | 84640 | 84646 | 84652 | 84658 | 84665 | 84671 | 84677 | 84683 | 84689 |
| 703 | 84696 | 84702 | 84708 | 84714 | 84720 | 84726 | 84733 | 84739 | 84745 | 84751 |
| 704 | 84757 | 84763 | 84770 | 84776 | 84782 | 84788 | 84794 | 84800 | 84807 | 84813 |
| 705 | 84819 | 84825 | 84831 | 84837 | 84844 | 84850 | 84856 | 84862 | 84868 | 84874 |
| 706 | 84880 | 84887 | 84893 | 84899 | 84905 | 84911 | 84917 | 84924 | 84930 | 84936 |
| 707 | 84942 | 84948 | 84954 | 84960 | 84967 | 84973 | 84979 | 84985 | 84991 | 84997 |
| 708 | 85003 | 85009 | 85016 | 85022 | 85028 | 85034 | 85040 | 85046 | 85052 | 85058 |
| 709 | 85065 | 85071 | 85077 | 85083 | 85089 | 85095 | 85101 | 85107 | 85114 | 85120 |
| 710 | 85126 | 85132 | 85138 | 85144 | 85150 | 85156 | 85163 | 85169 | 85175 | 85181 |
| 711 | 85187 | 85193 | 85199 | 85205 | 85211 | 85217 | 85224 | 85230 | 85236 | 85242 |
| 712 | 85248 | 85254 | 85260 | 85266 | 85272 | 85278 | 85285 | 85291 | 85297 | 85303 |
| 713 | 85309 | 85315 | 85321 | 85327 | 85333 | 85339 | 85345 | 85352 | 85358 | 85364 |
| 714 | 85370 | 85376 | 85382 | 85388 | 85394 | 85400 | 85406 | 85412 | 85418 | 85425 |
| 715 | 85431 | 85437 | 85443 | 85449 | 85455 | 85461 | 85467 | 85473 | 85479 | 85485 |
| 716 | 85491 | 85497 | 85503 | 85509 | 85516 | 85522 | 85528 | 85534 | 85540 | 85546 |
| 717 | 85552 | 85558 | 85564 | 85570 | 85576 | 85582 | 85588 | 85594 | 85600 | 85606 |
| 718 | 85612 | 85618 | 85625 | 85631 | 85637 | 85643 | 85649 | 85655 | 85661 | 85667 |
| 719 | 85673 | 85679 | 85685 | 85691 | 85697 | 85703 | 85709 | 85715 | 85721 | 85727 |
| 720 | 85733 | 85739 | 85745 | 85751 | 85757 | 85763 | 85769 | 85775 | 85781 | 85788 |
| 721 | 85794 | 85800 | 85806 | 85812 | 85818 | 85824 | 85830 | 85836 | 85842 | 85848 |
| 722 | 85854 | 85860 | 85866 | 85872 | 85878 | 85884 | 85890 | 85896 | 85902 | 85908 |
| 723 | 85914 | 85920 | 85926 | 85932 | 85938 | 85944 | 85950 | 85956 | 85962 | 85968 |
| 724 | 85974 | 85980 | 85986 | 85992 | 85998 | 86004 | 86010 | 86016 | 86022 | 86028 |
| 725 | 86034 | 86040 | 86046 | 86052 | 86058 | 86064 | 86070 | 86076 | 86082 | 86088 |
| 726 | 86094 | 86100 | 86106 | 86112 | 86118 | 86124 | 86130 | 86136 | 86141 | 86147 |
| 727 | 86153 | 86159 | 86165 | 86171 | 86177 | 86183 | 86189 | 86195 | 86201 | 86207 |
| 728 | 86213 | 86219 | 86225 | 86231 | 86237 | 86243 | 86249 | 86255 | 86261 | 86267 |
| 729 | 86273 | 86279 | 86285 | 86291 | 86297 | 86303 | 86308 | 86314 | 86320 | 86326 |
| 730 | 86332 | 86338 | 86344 | 86350 | 86356 | 86362 | 86368 | 86374 | 86380 | 86386 |
| 731 | 86392 | 86398 | 86404 | 86410 | 86415 | 86421 | 86427 | 86433 | 86439 | 86445 |
| 732 | 86451 | 86457 | 86463 | 86469 | 86475 | 86481 | 86487 | 86493 | 86499 | 86504 |
| 733 | 86510 | 86516 | 86522 | 86528 | 86534 | 86540 | 86546 | 86552 | 86558 | 86564 |
| 734 | 86570 | 86576 | 86581 | 86587 | 86593 | 86599 | 86605 | 86611 | 86617 | 86623 |
| 735 | 86629 | 86635 | 86641 | 86646 | 86652 | 86658 | 86664 | 86670 | 86676 | 86682 |
| 736 | 86688 | 86694 | 86700 | 86705 | 86711 | 86717 | 86723 | 86729 | 86735 | 86741 |
| 737 | 86747 | 86753 | 86759 | 86764 | 86770 | 86776 | 86782 | 86788 | 86794 | 86800 |
| 738 | 86806 | 86812 | 86817 | 86823 | 86829 | 86835 | 86841 | 86847 | 86853 | 86859 |
| 739 | 86864 | 86870 | 86876 | 86882 | 86888 | 86894 | 86900 | 86906 | 86911 | 86917 |
| 740 | 86923 | 86929 | 86935 | 86941 | 86947 | 86953 | 86958 | 86964 | 86970 | 86976 |
| 741 | 86982 | 86988 | 86994 | 86999 | 87005 | 87011 | 87017 | 87023 | 87029 | 87035 |
| 742 | 87040 | 87046 | 87052 | 87058 | 87064 | 87070 | 87075 | 87081 | 87087 | 87093 |
| 743 | 87099 | 87105 | 87111 | 87116 | 87122 | 87128 | 87134 | 87140 | 87146 | 87151 |
| 744 | 87157 | 87163 | 87169 | 87175 | 87181 | 87186 | 87192 | 87198 | 87204 | 87210 |
| 745 | 87216 | 87221 | 87227 | 87233 | 87239 | 87245 | 87251 | 87256 | 87262 | 87268 |
| 746 | 87274 | 87280 | 87286 | 87291 | 87297 | 87303 | 87309 | 87315 | 87320 | 87326 |
| 747 | 87332 | 87338 | 87344 | 87349 | 87355 | 87361 | 87367 | 87373 | 87379 | 87384 |
| 748 | 87390 | 87396 | 87402 | 87408 | 87413 | 87419 | 87425 | 87431 | 87437 | 87442 |
| 749 | 87448 | 87454 | 87460 | 87466 | 87471 | 87477 | 87483 | 87489 | 87495 | 87500 |
| 750 | 87506 | 87512 | 87518 | 87523 | 87529 | 87535 | 87541 | 87547 | 87552 | 87558 |
| 751 | 87564 | 87570 | 87576 | 87581 | 87587 | 87593 | 87599 | 87604 | 87610 | 87616 |
| 752 | 87622 | 87628 | 87633 | 87639 | 87645 | 87651 | 87656 | 87662 | 87668 | 87674 |
| 753 | 87679 | 87685 | 87691 | 87697 | 87703 | 87708 | 87714 | 87720 | 87726 | 87731 |
| 754 | 87737 | 87743 | 87749 | 87754 | 87760 | 87766 | 87772 | 87777 | 87783 | 87789 |
| 755 | 87795 | 87800 | 87806 | 87812 | 87818 | 87823 | 87829 | 87835 | 87841 | 87846 |
| 756 | 87852 | 87858 | 87864 | 87869 | 87875 | 87881 | 87887 | 87892 | 87898 | 87904 |
| 757 | 87910 | 87915 | 87921 | 87927 | 87933 | 87938 | 87944 | 87950 | 87955 | 87961 |
| 758 | 87967 | 87973 | 87978 | 87984 | 87990 | 87996 | 88001 | 88007 | 88013 | 88018 |
| 759 | 88024 | 88030 | 88036 | 88041 | 88047 | 88053 | 88058 | 88064 | 88070 | 88076 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Proportional parts:

**7**

| | |
|---|---|
| 1 | 1 |
| 2 | 1 |
| 3 | 2 |
| 4 | 3 |
| 5 | 4 |
| 6 | 4 |
| 7 | 5 |
| 8 | 6 |
| 9 | 6 |

**6**

| | |
|---|---|
| 1 | 1 |
| 2 | 1 |
| 3 | 2 |
| 4 | 2 |
| 5 | 3 |
| 6 | 4 |
| 7 | 4 |
| 8 | 5 |
| 9 | 5 |

**5**

| | |
|---|---|
| 1 | 1 |
| 2 | 1 |
| 3 | 2 |
| 4 | 2 |
| 5 | 3 |
| 6 | 3 |
| 7 | 4 |
| 8 | 4 |
| 9 | 5 |

TABLE 42. [Page 603

Logarithms of Numbers.

No. 7600——8200.      Log. 88081——91381.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 6 |
| 760 | 88081 | 88087 | 88093 | 88098 | 88104 | 88110 | 88116 | 88121 | 88127 | 88133 | | |
| 761 | 88138 | 88144 | 88150 | 88156 | 88161 | 88167 | 88173 | 88178 | 88184 | 88190 | 1 | 1 |
| 762 | 88195 | 88201 | 88207 | 88213 | 88218 | 88224 | 88230 | 88235 | 88241 | 88247 | 2 | 1 |
| 763 | 88252 | 88258 | 88264 | 88270 | 88275 | 88281 | 88287 | 88292 | 88298 | 88304 | 3 | 2 |
| 764 | 88309 | 88315 | 88321 | 88326 | 88332 | 88338 | 88343 | 88349 | 88355 | 88360 | 4 | 2 |
| 765 | 88366 | 88372 | 88377 | 88383 | 88389 | 88395 | 88400 | 88406 | 88412 | 88417 | 5 | 3 |
| 766 | 88423 | 88429 | 88434 | 88440 | 88446 | 88451 | 88457 | 88463 | 88468 | 88474 | 6 | 4 |
| 767 | 88480 | 88485 | 88491 | 88497 | 88502 | 88508 | 88513 | 88519 | 88525 | 88530 | 7 | 4 |
| 768 | 88536 | 88542 | 88547 | 88553 | 88559 | 88564 | 88570 | 88576 | 88581 | 88587 | 8 | 5 |
| 769 | 88593 | 88598 | 88604 | 88610 | 88615 | 88621 | 88627 | 88632 | 88638 | 88643 | 9 | 5 |
| 770 | 88649 | 88655 | 88660 | 88666 | 88672 | 88677 | 88683 | 88689 | 88694 | 88700 | | |
| 771 | 88705 | 88711 | 88717 | 88722 | 88728 | 88734 | 88739 | 88745 | 88750 | 88756 | | |
| 772 | 88762 | 88767 | 88773 | 88779 | 88784 | 88790 | 88795 | 88801 | 88807 | 88812 | | |
| 773 | 88818 | 88824 | 88829 | 88835 | 88840 | 88846 | 88852 | 88857 | 88863 | 88868 | | |
| 774 | 88874 | 88880 | 88885 | 88891 | 88897 | 88902 | 88908 | 88913 | 88919 | 88925 | | |
| 775 | 88930 | 88936 | 88941 | 88947 | 88953 | 88958 | 88964 | 88969 | 88975 | 88981 | | |
| 776 | 88986 | 88992 | 88997 | 89003 | 89009 | 89014 | 89020 | 89025 | 89031 | 89037 | | |
| 777 | 89042 | 89048 | 89053 | 89059 | 89064 | 89070 | 89076 | 89081 | 89087 | 89092 | | |
| 778 | 89098 | 89104 | 89109 | 89115 | 89120 | 89126 | 89131 | 89137 | 89143 | 89148 | | |
| 779 | 89154 | 89159 | 89165 | 89170 | 89176 | 89182 | 89187 | 89193 | 89198 | 89204 | | |
| 780 | 89209 | 89215 | 89221 | 89226 | 89232 | 89237 | 89243 | 89248 | 89254 | 89260 | | |
| 781 | 89265 | 89271 | 89276 | 89282 | 89287 | 89293 | 89298 | 89304 | 89310 | 89315 | | |
| 782 | 89321 | 89326 | 89332 | 89337 | 89343 | 89348 | 89354 | 89360 | 89365 | 89371 | | |
| 783 | 89376 | 89382 | 89387 | 89393 | 89398 | 89404 | 89409 | 89415 | 89421 | 89426 | | |
| 784 | 89432 | 89437 | 89443 | 89448 | 89454 | 89459 | 89465 | 89470 | 89476 | 89481 | | |
| 785 | 89487 | 89492 | 89498 | 89504 | 89509 | 89515 | 89520 | 89526 | 89531 | 89537 | | |
| 786 | 89542 | 89548 | 89553 | 89559 | 89564 | 89570 | 89575 | 89581 | 89586 | 89592 | | |
| 787 | 89597 | 89603 | 89609 | 89614 | 89620 | 89625 | 89631 | 89636 | 89642 | 89647 | | |
| 788 | 89653 | 89658 | 89664 | 89669 | 89675 | 89680 | 89686 | 89691 | 89697 | 89702 | | |
| 789 | 89708 | 89713 | 89719 | 89724 | 89730 | 89735 | 89741 | 89746 | 89752 | 89757 | | |
| 790 | 89763 | 89768 | 89774 | 89779 | 89785 | 89790 | 89796 | 89801 | 89807 | 89812 | | |
| 791 | 89818 | 89823 | 89829 | 89834 | 89840 | 89845 | 89851 | 89856 | 89862 | 89867 | | |
| 792 | 89873 | 89878 | 89883 | 89889 | 89894 | 89900 | 89905 | 89911 | 89916 | 89922 | | |
| 793 | 89927 | 89933 | 89938 | 89944 | 89949 | 89955 | 89960 | 89966 | 89971 | 89977 | | |
| 794 | 89982 | 89988 | 89993 | 89998 | 90004 | 90009 | 90015 | 90020 | 90026 | 90031 | | |
| 795 | 90037 | 90042 | 90048 | 90053 | 90059 | 90064 | 90069 | 90075 | 90080 | 90086 | | |
| 796 | 90091 | 90097 | 90102 | 90108 | 90113 | 90119 | 90124 | 90129 | 90135 | 90140 | | |
| 797 | 90146 | 90151 | 90157 | 90162 | 90168 | 90173 | 90179 | 90184 | 90189 | 90195 | | |
| 798 | 90200 | 90206 | 90211 | 90217 | 90222 | 90227 | 90233 | 90238 | 90244 | 90249 | | |
| 799 | 90255 | 90260 | 90266 | 90271 | 90276 | 90282 | 90287 | 90293 | 90298 | 90304 | | |
| 800 | 90309 | 90314 | 90320 | 90325 | 90331 | 90336 | 90342 | 90347 | 90352 | 90358 | | |
| 801 | 90363 | 90369 | 90374 | 90380 | 90385 | 90390 | 90396 | 90401 | 90407 | 90412 | | |
| 802 | 90417 | 90423 | 90428 | 90434 | 90439 | 90445 | 90450 | 90455 | 90461 | 90466 | | |
| 803 | 90472 | 90477 | 90482 | 90488 | 90493 | 90499 | 90504 | 90509 | 90515 | 90520 | | |
| 804 | 90526 | 90531 | 90536 | 90542 | 90547 | 90553 | 90558 | 90563 | 90569 | 90574 | | |
| 805 | 90580 | 90585 | 90590 | 90596 | 90601 | 90607 | 90612 | 90617 | 90623 | 90628 | | |
| 806 | 90634 | 90639 | 90644 | 90650 | 90655 | 90660 | 90666 | 90671 | 90677 | 90682 | | |
| 807 | 90687 | 90693 | 90698 | 90703 | 90709 | 90714 | 90720 | 90725 | 90730 | 90736 | | |
| 808 | 90741 | 90747 | 90752 | 90757 | 90763 | 90768 | 90773 | 90779 | 90784 | 90789 | | |
| 809 | 90795 | 90800 | 90806 | 90811 | 90816 | 90822 | 90827 | 90832 | 90838 | 90843 | | 5 |
| 810 | 90849 | 90854 | 90859 | 90865 | 90870 | 90875 | 90881 | 90886 | 90891 | 90897 | | |
| 811 | 90902 | 90907 | 90913 | 90918 | 90924 | 90929 | 90934 | 90940 | 90945 | 90950 | 1 | 1 |
| 812 | 90956 | 90961 | 90966 | 90972 | 90977 | 90982 | 90988 | 90993 | 90998 | 91004 | 2 | 1 |
| 813 | 91009 | 91014 | 91020 | 91025 | 91030 | 91036 | 91041 | 91046 | 91052 | 91057 | 3 | 2 |
| 814 | 91062 | 91068 | 91073 | 91078 | 91084 | 91089 | 91094 | 91100 | 91105 | 91110 | 4 | 2 |
| 815 | 91116 | 91121 | 91126 | 91132 | 91137 | 91142 | 91148 | 91153 | 91158 | 91164 | 5 | 3 |
| 816 | 91169 | 91174 | 91180 | 91185 | 91190 | 91196 | 91201 | 91206 | 91212 | 91217 | 6 | 3 |
| 817 | 91222 | 91228 | 91233 | 91238 | 91243 | 91249 | 91254 | 91259 | 91265 | 91270 | 7 | 4 |
| 818 | 91275 | 91281 | 91286 | 91291 | 91297 | 91302 | 91307 | 91312 | 91318 | 91323 | 8 | 4 |
| 819 | 91328 | 91334 | 91339 | 91344 | 91350 | 91355 | 91360 | 91365 | 91371 | 91376 | 9 | 5 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |

# TABLE 42.

Logarithms of Numbers.

No. 8200——8800.                                        Log. 91381——94448

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|---|
| | | | | | | | | | | | | **6** |
| 820 | 91381 | 91387 | 91392 | 91397 | 91403 | 91408 | 91413 | 91418 | 91424 | 91429 | | |
| 821 | 91434 | 91440 | 91445 | 91450 | 91455 | 91461 | 91466 | 91471 | 91477 | 91482 | | |
| 822 | 91487 | 91492 | 91498 | 91503 | 91508 | 91514 | 91519 | 91524 | 91529 | 91535 | 1 | 1 |
| 823 | 91540 | 91545 | 91551 | 91556 | 91561 | 91566 | 91572 | 91577 | 91582 | 91587 | 2 | 1 |
| 824 | 91593 | 91598 | 91603 | 91609 | 91614 | 91619 | 91624 | 91630 | 91635 | 91640 | 3 | 2 |
| 825 | 91645 | 91651 | 91656 | 91661 | 91666 | 91672 | 91677 | 91682 | 91687 | 91693 | 4 | 2 |
| 826 | 91698 | 91703 | 91709 | 91714 | 91719 | 91724 | 91730 | 91735 | 91740 | 91745 | 5 | 3 |
| 827 | 91751 | 91756 | 91761 | 91766 | 91772 | 91777 | 91782 | 91787 | 91793 | 91798 | 6 | 4 |
| 828 | 91803 | 91808 | 91814 | 91819 | 91824 | 91829 | 91834 | 91840 | 91845 | 91850 | 7 | 4 |
| 829 | 91855 | 91861 | 91866 | 91871 | 91876 | 91882 | 91887 | 91892 | 91897 | 91903 | 8 | 5 |
| 830 | 91908 | 91913 | 91918 | 91924 | 91929 | 91934 | 91939 | 91944 | 91950 | 91955 | 9 | 5 |
| 831 | 91960 | 91965 | 91971 | 91976 | 91981 | 91986 | 91991 | 91997 | 92002 | 92007 | | |
| 832 | 92012 | 92018 | 92023 | 92028 | 92033 | 92038 | 92044 | 92049 | 92054 | 92059 | | |
| 833 | 92065 | 92070 | 92075 | 92080 | 92085 | 92091 | 92096 | 92101 | 92106 | 92111 | | |
| 834 | 92117 | 92122 | 92127 | 92132 | 92137 | 92143 | 92148 | 92153 | 92158 | 92163 | | |
| 835 | 92169 | 92174 | 92179 | 92184 | 92189 | 92195 | 92200 | 92205 | 92210 | 92215 | | |
| 836 | 92221 | 92226 | 92231 | 92236 | 92241 | 92247 | 92252 | 92257 | 92262 | 92267 | | |
| 837 | 92273 | 92278 | 92283 | 92288 | 92293 | 92298 | 92304 | 92309 | 92314 | 92319 | | |
| 838 | 92324 | 92330 | 92335 | 92340 | 92345 | 92350 | 92355 | 92361 | 92366 | 92371 | | |
| 839 | 92376 | 92381 | 92387 | 92392 | 92397 | 92402 | 92407 | 92412 | 92418 | 92423 | | |
| 840 | 92428 | 92433 | 92438 | 92443 | 92449 | 92454 | 92459 | 92464 | 92469 | 92474 | | |
| 841 | 92480 | 92485 | 92490 | 92495 | 92500 | 92505 | 92511 | 92516 | 92521 | 92526 | | |
| 842 | 92531 | 92536 | 92542 | 92547 | 92552 | 92557 | 92562 | 92567 | 92572 | 92578 | | |
| 843 | 92583 | 92588 | 92593 | 92598 | 92603 | 92609 | 92614 | 92619 | 92624 | 92629 | | |
| 844 | 92634 | 92639 | 92645 | 92650 | 92655 | 92660 | 92665 | 92670 | 92675 | 92681 | | **5** |
| 845 | 92686 | 92691 | 92696 | 92701 | 92706 | 92711 | 92716 | 92722 | 92727 | 92732 | | |
| 846 | 92737 | 92742 | 92747 | 92752 | 92758 | 92763 | 92768 | 92773 | 92778 | 92783 | 1 | 1 |
| 847 | 92788 | 92793 | 92799 | 92804 | 92809 | 92814 | 92819 | 92824 | 92829 | 92834 | 2 | 1 |
| 848 | 92840 | 92845 | 92850 | 92855 | 92860 | 92865 | 92870 | 92875 | 92881 | 92886 | 3 | 2 |
| 849 | 92891 | 92896 | 92901 | 92906 | 92911 | 92916 | 92921 | 92927 | 92932 | 92937 | 4 | 2 |
| 850 | 92942 | 92947 | 92952 | 92957 | 92962 | 92967 | 92973 | 92978 | 92983 | 92988 | 5 | 3 |
| 851 | 92993 | 92998 | 93003 | 93008 | 93013 | 93018 | 93024 | 93029 | 93034 | 93039 | 6 | 3 |
| 852 | 93044 | 93049 | 93054 | 93059 | 93064 | 93069 | 93075 | 93080 | 93085 | 93090 | 7 | 4 |
| 853 | 93095 | 93100 | 93105 | 93110 | 93115 | 93120 | 93125 | 93131 | 93136 | 93141 | 8 | 4 |
| 854 | 93146 | 93151 | 93156 | 93161 | 93166 | 93171 | 93176 | 93181 | 93186 | 93192 | 9 | 5 |
| 855 | 93197 | 93202 | 93207 | 93212 | 93217 | 93222 | 93227 | 93232 | 93237 | 93242 | | |
| 856 | 93247 | 93252 | 93258 | 93263 | 93268 | 93273 | 93278 | 93283 | 93288 | 93293 | | |
| 857 | 93298 | 93303 | 93308 | 93313 | 93318 | 93323 | 93328 | 93334 | 93339 | 93344 | | |
| 858 | 93349 | 93354 | 93359 | 93364 | 93369 | 93374 | 93379 | 93384 | 93389 | 93394 | | |
| 859 | 93399 | 93404 | 93409 | 93414 | 93420 | 93425 | 93430 | 93435 | 93440 | 93445 | | |
| 860 | 93450 | 93455 | 93460 | 93465 | 93470 | 93475 | 93480 | 93485 | 93490 | 93495 | | |
| 861 | 93500 | 93505 | 93510 | 93515 | 93520 | 93526 | 93531 | 93536 | 93541 | 93546 | | |
| 862 | 93551 | 93556 | 93561 | 93566 | 93571 | 93576 | 93581 | 93586 | 93591 | 93596 | | |
| 863 | 93601 | 93606 | 93611 | 93616 | 93621 | 93626 | 93631 | 93636 | 93641 | 93646 | | |
| 864 | 93651 | 93656 | 93661 | 93666 | 93671 | 93676 | 93682 | 93687 | 93692 | 93697 | | |
| 865 | 93702 | 93707 | 93712 | 93717 | 93722 | 93727 | 93732 | 93737 | 93742 | 93747 | | |
| 866 | 93752 | 93757 | 93762 | 93767 | 93772 | 93777 | 93782 | 93787 | 93792 | 93797 | | |
| 867 | 93802 | 93807 | 93812 | 93817 | 93822 | 93827 | 93832 | 93837 | 93842 | 93847 | | |
| 868 | 93852 | 93857 | 93862 | 93867 | 93872 | 93877 | 93882 | 93887 | 93892 | 93897 | | |
| 869 | 93902 | 93907 | 93912 | 93917 | 93922 | 93927 | 93932 | 93937 | 93942 | 93947 | | **4** |
| 870 | 93952 | 93957 | 93962 | 93967 | 93972 | 93977 | 93982 | 93987 | 93992 | 93997 | | |
| 871 | 94002 | 94007 | 94012 | 94017 | 94022 | 94027 | 94032 | 94037 | 94042 | 94047 | 1 | 0 |
| 872 | 94052 | 94057 | 94062 | 94067 | 94072 | 94077 | 94082 | 94086 | 94091 | 94096 | 2 | 1 |
| 873 | 94101 | 94106 | 94111 | 94116 | 94121 | 94126 | 94131 | 94136 | 94141 | 94146 | 3 | 1 |
| 874 | 94151 | 94156 | 94161 | 94166 | 94171 | 94176 | 94181 | 94186 | 94191 | 94196 | 4 | 2 |
| 875 | 94201 | 94206 | 94211 | 94216 | 94221 | 94226 | 94231 | 94236 | 94240 | 94245 | 5 | 2 |
| 876 | 94250 | 94255 | 94260 | 94265 | 94270 | 94275 | 94280 | 94285 | 94290 | 94295 | 6 | 2 |
| 877 | 94300 | 94305 | 94310 | 94315 | 94320 | 94325 | 94330 | 94335 | 94340 | 94345 | 7 | 3 |
| 878 | 94349 | 94354 | 94359 | 94364 | 94369 | 94374 | 94379 | 94384 | 94389 | 94394 | 8 | 3 |
| 879 | 94399 | 94404 | 94409 | 94414 | 94419 | 94424 | 94429 | 94433 | 94438 | 94443 | 9 | 4 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |

TABLE 42.

[Page 605

Logarithms of Numbers.

No. 8800——9400.  Log. 94448——97313.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 880 | 94448 | 94453 | 94458 | 94463 | 94468 | 94473 | 94478 | 94483 | 94488 | 94493 |
| 881 | 94498 | 94503 | 94507 | 94512 | 94517 | 94522 | 94527 | 94532 | 94537 | 94542 |
| 882 | 94547 | 94552 | 94557 | 94562 | 94567 | 94571 | 94576 | 94581 | 94586 | 94591 |
| 883 | 94596 | 94601 | 94606 | 94611 | 94616 | 94621 | 94626 | 94630 | 94635 | 94640 |
| 884 | 94645 | 94650 | 94655 | 94660 | 94665 | 94670 | 94675 | 94680 | 94685 | 94689 |
| 885 | 94694 | 94699 | 94704 | 94709 | 94714 | 94719 | 94724 | 94729 | 94734 | 94738 |
| 886 | 94743 | 94748 | 94753 | 94758 | 94763 | 94768 | 94773 | 94778 | 94783 | 94787 |
| 887 | 94792 | 94797 | 94802 | 94807 | 94812 | 94817 | 94822 | 94827 | 94832 | 94836 |
| 888 | 94841 | 94846 | 94851 | 94856 | 94861 | 94866 | 94871 | 94876 | 94880 | 94885 |
| 889 | 94890 | 94895 | 94900 | 94905 | 94910 | 94915 | 94919 | 94924 | 94929 | 94934 |
| 890 | 94939 | 94944 | 94949 | 94954 | 94959 | 94963 | 94968 | 94973 | 94978 | 94983 |
| 891 | 94988 | 94993 | 94998 | 95002 | 95007 | 95012 | 95017 | 95022 | 95027 | 95032 |
| 892 | 95036 | 95041 | 95046 | 95051 | 95056 | 95061 | 95066 | 95071 | 95075 | 95080 |
| 893 | 95085 | 95090 | 95095 | 95100 | 95105 | 95109 | 95114 | 95119 | 95124 | 95129 |
| 894 | 95134 | 95139 | 95143 | 95148 | 95153 | 95158 | 95163 | 95168 | 95173 | 95177 |
| 895 | 95182 | 95187 | 95192 | 95197 | 95202 | 95207 | 95211 | 95216 | 95221 | 95226 |
| 896 | 95231 | 95236 | 95240 | 95245 | 95250 | 95255 | 95260 | 95265 | 95270 | 95274 |
| 897 | 95279 | 95284 | 95289 | 95294 | 95299 | 95303 | 95308 | 95313 | 95318 | 95323 |
| 898 | 95328 | 95332 | 95337 | 95342 | 95347 | 95352 | 95357 | 95361 | 95366 | 95371 |
| 899 | 95376 | 95381 | 95386 | 95390 | 95395 | 95400 | 95405 | 95410 | 95415 | 95419 |
| 900 | 95424 | 95429 | 95434 | 95439 | 95444 | 95448 | 95453 | 95458 | 95463 | 95468 |
| 901 | 95472 | 95477 | 95482 | 95487 | 95492 | 95497 | 95501 | 95506 | 95511 | 95516 |
| 902 | 95521 | 95525 | 95530 | 95535 | 95540 | 95545 | 95550 | 95554 | 95559 | 95564 |
| 903 | 95569 | 95574 | 95578 | 95583 | 95588 | 95593 | 95598 | 95602 | 95607 | 95612 |
| 904 | 95617 | 95622 | 95626 | 95631 | 95636 | 95641 | 95646 | 95650 | 95655 | 95660 |
| 905 | 95665 | 95670 | 95674 | 95679 | 95684 | 95689 | 95694 | 95698 | 95703 | 95708 |
| 906 | 95713 | 95718 | 95722 | 95727 | 95732 | 95737 | 95742 | 95746 | 95751 | 95756 |
| 907 | 95761 | 95766 | 95770 | 95775 | 95780 | 95785 | 95789 | 95794 | 95799 | 95804 |
| 908 | 95809 | 95813 | 95818 | 95823 | 95828 | 95832 | 95837 | 95842 | 95847 | 95852 |
| 909 | 95856 | 95861 | 95866 | 95871 | 95875 | 95880 | 95885 | 95890 | 95895 | 95899 |
| 910 | 95904 | 95909 | 95914 | 95918 | 95923 | 95928 | 95933 | 95938 | 95942 | 95947 |
| 911 | 95952 | 95957 | 95961 | 95966 | 95971 | 95976 | 95980 | 95985 | 95990 | 95995 |
| 912 | 95999 | 96004 | 96009 | 96014 | 96019 | 96023 | 96028 | 96033 | 96038 | 96042 |
| 913 | 96047 | 96052 | 96057 | 96061 | 96066 | 96071 | 96076 | 96080 | 96085 | 96090 |
| 914 | 96095 | 96099 | 96104 | 96109 | 96114 | 96118 | 96123 | 96128 | 96133 | 96137 |
| 915 | 96142 | 96147 | 96152 | 96156 | 96161 | 96166 | 96171 | 96175 | 96180 | 96185 |
| 916 | 96190 | 96194 | 96199 | 96204 | 96209 | 96213 | 96218 | 96223 | 96227 | 96232 |
| 917 | 96237 | 96242 | 96246 | 96251 | 96256 | 96261 | 96265 | 96270 | 96275 | 96280 |
| 918 | 96284 | 96289 | 96294 | 96298 | 96303 | 96308 | 96313 | 96317 | 96322 | 96327 |
| 919 | 96332 | 96336 | 96341 | 96346 | 96350 | 96355 | 96360 | 96365 | 96369 | 96374 |
| 920 | 96379 | 96384 | 96388 | 96393 | 96398 | 96402 | 96407 | 96412 | 96417 | 96421 |
| 921 | 96426 | 96431 | 96435 | 96440 | 96445 | 96450 | 96454 | 96459 | 96464 | 96468 |
| 922 | 96473 | 96478 | 96483 | 96487 | 96492 | 96497 | 96501 | 96506 | 96511 | 96515 |
| 923 | 96520 | 96525 | 96530 | 96534 | 96539 | 96544 | 96548 | 96553 | 96558 | 96562 |
| 924 | 96567 | 96572 | 96577 | 96581 | 96586 | 96591 | 96595 | 96600 | 96605 | 96609 |
| 925 | 96614 | 96619 | 96624 | 96628 | 96633 | 96638 | 96642 | 96647 | 96652 | 96656 |
| 926 | 96661 | 96666 | 96670 | 96675 | 96680 | 96685 | 96689 | 96694 | 96699 | 96703 |
| 927 | 96708 | 96713 | 96717 | 96722 | 96727 | 96731 | 96736 | 96741 | 96745 | 96750 |
| 928 | 96755 | 96759 | 96764 | 96769 | 96774 | 96778 | 96783 | 96788 | 96792 | 96797 |
| 929 | 96802 | 96806 | 96811 | 96816 | 96820 | 96825 | 96830 | 96834 | 96839 | 96844 |
| 930 | 96848 | 96853 | 96858 | 96862 | 96867 | 96872 | 96876 | 96881 | 96886 | 96890 |
| 931 | 96895 | 96900 | 96904 | 96909 | 96914 | 96918 | 96923 | 96928 | 96932 | 96937 |
| 932 | 96942 | 96946 | 96951 | 96956 | 96960 | 96965 | 96970 | 96974 | 96979 | 96984 |
| 933 | 96988 | 96993 | 96997 | 97002 | 97007 | 97011 | 97016 | 97021 | 97025 | 97030 |
| 934 | 97035 | 97039 | 97044 | 97049 | 97053 | 97058 | 97063 | 97067 | 97072 | 97077 |
| 935 | 97081 | 97086 | 97090 | 97095 | 97100 | 97104 | 97109 | 97114 | 97118 | 97123 |
| 936 | 97128 | 97132 | 97137 | 97142 | 97146 | 97151 | 97155 | 97160 | 97165 | 97169 |
| 937 | 97174 | 97179 | 97183 | 97188 | 97192 | 97197 | 97202 | 97206 | 97211 | 97216 |
| 938 | 97220 | 97225 | 97230 | 97234 | 97239 | 97243 | 97248 | 97253 | 97257 | 97262 |
| 939 | 97267 | 97271 | 97276 | 97280 | 97285 | 97290 | 97294 | 97299 | 97304 | 97308 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Proportional parts:

| | 5 |
|---|---|
| 1 | 1 |
| 2 | 1 |
| 3 | 2 |
| 4 | 2 |
| 5 | 3 |
| 6 | 3 |
| 7 | 4 |
| 8 | 4 |
| 9 | 5 |

| | 4 |
|---|---|
| 1 | 0 |
| 2 | 1 |
| 3 | 1 |
| 4 | 2 |
| 5 | 2 |
| 6 | 2 |
| 7 | 3 |
| 8 | 3 |
| 9 | 4 |

# TABLE 42.

Logarithms of Numbers.

No. 9400——10000.                                                                Log. 97313——99996.

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|---|
| | | | | | | | | | | | | 5 |
| 940 | 97313 | 97317 | 97322 | 97327 | 97331 | 97336 | 97340 | 97345 | 97350 | 97354 | | |
| 941 | 97359 | 97364 | 97368 | 97373 | 97377 | 97382 | 97387 | 97391 | 97396 | 97400 | | |
| 942 | 97405 | 97410 | 97414 | 97419 | 97424 | 97428 | 97433 | 97437 | 97442 | 97447 | 1 | 1 |
| 943 | 97451 | 97456 | 97460 | 97465 | 97470 | 97474 | 97479 | 97483 | 97488 | 97493 | 2 | 1 |
| 944 | 97497 | 97502 | 97506 | 97511 | 97516 | 97520 | 97525 | 97529 | 97534 | 97539 | 3 | 2 |
| 945 | 97543 | 97548 | 97552 | 97557 | 97562 | 97566 | 97571 | 97575 | 97580 | 97585 | 4 | 2 |
| 946 | 97589 | 97594 | 97598 | 97603 | 97607 | 97612 | 97617 | 97621 | 97626 | 97630 | 5 | 3 |
| 947 | 97635 | 97640 | 97644 | 97649 | 97653 | 97658 | 97663 | 97667 | 97672 | 97676 | 6 | 3 |
| 948 | 97681 | 97685 | 97690 | 97695 | 97699 | 97704 | 97708 | 97713 | 97717 | 97722 | 7 | 4 |
| 949 | 97727 | 97731 | 97736 | 97740 | 97745 | 97749 | 97754 | 97759 | 97763 | 97768 | 8 | 4 |
| 950 | 97772 | 97777 | 97782 | 97786 | 97791 | 97795 | 97800 | 97804 | 97809 | 97813 | 9 | 5 |
| 951 | 97818 | 97823 | 97827 | 97832 | 97836 | 97841 | 97845 | 97850 | 97855 | 97859 | | |
| 952 | 97864 | 97868 | 97873 | 97877 | 97882 | 97886 | 97891 | 97896 | 97900 | 97905 | | |
| 953 | 97909 | 97914 | 97918 | 97923 | 97928 | 97932 | 97937 | 97941 | 97946 | 97950 | | |
| 954 | 97955 | 97959 | 97964 | 97968 | 97973 | 97978 | 97982 | 97987 | 97991 | 97996 | | |
| 955 | 98000 | 98005 | 98009 | 98014 | 98019 | 98023 | 98028 | 98032 | 98037 | 98041 | | |
| 956 | 98046 | 98050 | 98055 | 98059 | 98064 | 98068 | 98073 | 98078 | 98082 | 98087 | | |
| 957 | 98091 | 98096 | 98100 | 98105 | 98109 | 98114 | 98118 | 98123 | 98127 | 98132 | | |
| 958 | 98137 | 98141 | 98146 | 98150 | 98155 | 98159 | 98164 | 98168 | 98173 | 98177 | | |
| 959 | 98182 | 98186 | 98191 | 98195 | 98200 | 98204 | 98209 | 98214 | 98218 | 98223 | | |
| 960 | 98227 | 98232 | 98236 | 98241 | 98245 | 98250 | 98254 | 98259 | 98263 | 98268 | | |
| 961 | 98272 | 98277 | 98281 | 98286 | 98290 | 98295 | 98299 | 98304 | 98308 | 98313 | | |
| 962 | 98318 | 98322 | 98327 | 98331 | 98336 | 98340 | 98345 | 98349 | 98354 | 98358 | | |
| 963 | 98363 | 98367 | 98372 | 98376 | 98381 | 98385 | 98390 | 98394 | 98399 | 98403 | | |
| 964 | 98408 | 98412 | 98417 | 98421 | 98426 | 98430 | 98435 | 98439 | 98444 | 98448 | | |
| 965 | 98453 | 98457 | 98462 | 98466 | 98471 | 98475 | 98480 | 98484 | 98489 | 98493 | | |
| 966 | 98498 | 98502 | 98507 | 98511 | 98516 | 98520 | 98525 | 98529 | 98534 | 98538 | | |
| 967 | 98543 | 98547 | 98552 | 98556 | 98561 | 98565 | 98570 | 98574 | 98579 | 98583 | | |
| 968 | 98588 | 98592 | 98597 | 98601 | 98605 | 98610 | 98614 | 98619 | 98623 | 98628 | | |
| 969 | 98632 | 98637 | 98641 | 98646 | 98650 | 98655 | 98659 | 98664 | 98668 | 98673 | | |
| 970 | 98677 | 98682 | 98686 | 98691 | 98695 | 98700 | 98704 | 98709 | 98713 | 98717 | | |
| 971 | 98722 | 98726 | 98731 | 98735 | 98740 | 98744 | 98749 | 98753 | 98758 | 98762 | | |
| 972 | 98767 | 98771 | 98776 | 98780 | 98784 | 98789 | 98793 | 98798 | 98802 | 98807 | | |
| 973 | 98811 | 98816 | 98820 | 98825 | 98829 | 98834 | 98838 | 98843 | 98847 | 98851 | | |
| 974 | 98856 | 98860 | 98865 | 98869 | 98874 | 98878 | 98883 | 98887 | 98892 | 98896 | | |
| 975 | 98900 | 98905 | 98909 | 98914 | 98918 | 98923 | 98927 | 98932 | 98936 | 98941 | | |
| 976 | 98945 | 98949 | 98954 | 98958 | 98963 | 98967 | 98972 | 98976 | 98981 | 98985 | | |
| 977 | 98989 | 98994 | 98998 | 99003 | 99007 | 99012 | 99016 | 99021 | 99025 | 99029 | | |
| 978 | 99034 | 99038 | 99043 | 99047 | 99052 | 99056 | 99061 | 99065 | 99069 | 99074 | | |
| 979 | 99078 | 99083 | 99087 | 99092 | 99096 | 99100 | 99105 | 99109 | 99114 | 99118 | | |
| 980 | 99123 | 99127 | 99131 | 99136 | 99140 | 99145 | 99149 | 99154 | 99158 | 99162 | | |
| 981 | 99167 | 99171 | 99176 | 99180 | 99185 | 99189 | 99193 | 99198 | 99202 | 99207 | | |
| 982 | 99211 | 99216 | 99220 | 99224 | 99229 | 99233 | 99238 | 99242 | 99247 | 99251 | | |
| 983 | 99255 | 99260 | 99264 | 99269 | 99273 | 99277 | 99282 | 99286 | 99291 | 99295 | | |
| 984 | 99300 | 99304 | 99308 | 99313 | 99317 | 99322 | 99326 | 99330 | 99335 | 99339 | | |
| 985 | 99344 | 99348 | 99352 | 99357 | 99361 | 99366 | 99370 | 99374 | 99379 | 99383 | | |
| 986 | 99388 | 99392 | 99396 | 99401 | 99405 | 99410 | 99414 | 99419 | 99423 | 99427 | | |
| 987 | 99432 | 99436 | 99441 | 99445 | 99449 | 99454 | 99458 | 99463 | 99467 | 99471 | | |
| 988 | 99476 | 99480 | 99484 | 99489 | 99493 | 99498 | 99502 | 99506 | 99511 | 99515 | | |
| 989 | 99520 | 99524 | 99528 | 99533 | 99537 | 99542 | 99546 | 99550 | 99555 | 99559 | | 4 |
| 990 | 99564 | 99568 | 99572 | 99577 | 99581 | 99585 | 99590 | 99594 | 99599 | 99603 | | |
| 991 | 99607 | 99612 | 99616 | 99621 | 99625 | 99629 | 99634 | 99638 | 99642 | 99647 | 1 | 0 |
| 992 | 99651 | 99656 | 99660 | 99664 | 99669 | 99673 | 99677 | 99682 | 99686 | 99691 | 2 | 1 |
| 993 | 99695 | 99699 | 99704 | 99708 | 99712 | 99717 | 99721 | 99726 | 99730 | 99734 | 3 | 1 |
| 994 | 99739 | 99743 | 99747 | 99752 | 99756 | 99760 | 99765 | 99769 | 99774 | 99778 | 4 | 2 |
| 995 | 99782 | 99787 | 99791 | 99795 | 99800 | 99804 | 99808 | 99813 | 99817 | 99822 | 5 | 2 |
| 996 | 99826 | 99830 | 99835 | 99839 | 99843 | 99848 | 99852 | 99856 | 99861 | 99865 | 6 | 2 |
| 997 | 99870 | 99874 | 99878 | 99883 | 99887 | 99891 | 99896 | 99900 | 99904 | 99909 | 7 | 3 |
| 998 | 99913 | 99917 | 99922 | 99926 | 99930 | 99935 | 99939 | 99944 | 99948 | 99952 | 8 | 3 |
| 999 | 99957 | 99961 | 99965 | 99970 | 99974 | 99978 | 99983 | 99987 | 99991 | 99996 | 9 | 4 |
| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | |

TABLE 43. [Page 607

Logarithmic Sines, Tangents, and Secants to every Point and Quarter Point of the Compass.

| Points. | Sine. | Cosine. | Tangent. | Cotangent. | Secant. | Cosecant. | |
|---|---|---|---|---|---|---|---|
| 0 | Inf. neg. | 10. 00000 | Inf. neg. | Infinite. | 10. 00000 | Infinite. | 8 |
| ¼ | 8. 69080 | 9. 99948 | 8. 69132 | 11. 30868 | 10. 00052 | 11. 30920 | 7¾ |
| ½ | 8. 99130 | 9. 99790 | 8. 99340 | 11. 00660 | 10. 00210 | 11. 00870 | 7½ |
| ¾ | 9. 16652 | 9. 99527 | 9. 17125 | 10. 82875 | 10. 00473 | 10. 83348 | · 7¼ |
| 1 | 9. 29024 | 9. 99157 | · 9. 29866 | 10. 70134 | 10. 00843 | 10. 70976 | 7 |
| 1¼ | 9. 38557 | 9. 98679 | 9. 39879 | · 10. 60121 | 10. 01321 | 10. 61443 | 6¾ |
| 1½ | 9. 46282 | 9. 98088 | 9. 48194 | 10. 51806 | 10. 01912 | 10. 53718 | 6½ |
| 1¾ | 9. 52749 | 9. 97384 | 9. 55365 | 10. 44635 | 10. 02616 | 10. 47251 | 6¼ |
| 2 | 9. 58284 | 9. 96562 | 9. 61722 | 10. 38278 | 10. 03438 | 10. 41716 | 6 |
| 2¼ | 9. 63099 | 9. 95616 | 9. 67483 | 10. 32517 | 10. 04384 | 10. 36901 | 5¾ |
| 2½ | 9. 67339 | 9. 94543 | 9. 72796 | 10. 27204 | 10. 05457 | 10. 32661 | 5½ |
| 2¾ | 9. 71105 | 9. 93335 | 9. 77770 | 10. 22230 | 10. 06665 | 10. 28895 | 5¼ |
| 3 | 9. 74474 | 9. 91985 | 9. 82489 | 10. 17511 | 10. 08015 | 10. 25526 | 5 |
| 3¼ | 9. 77503 | 9. 90483 | 9. 87020 | 10. 12980 | 10. 09517 | 10. 22497 | 4¾ |
| 3½ | 9. 80236 | 9. 88819 | 9. 91417 | 10. 08583 | 10. 11181 | 10. 19764 | 4½ |
| 3¾ | 9. 82708 | 9. 86979 | 9. 95729 | 10. 04271 | 10. 13021 | 10. 17292 | 4¼ |
| 4 | 9. 84949 | 9. 84949 | 10. 00000 | 10. 00000 | 10. 15051 | 10. 15051 | 4 |
| | Cosine. | Sine. | Cotangent. | Tangent. | Cosecant. | Secant. | Points. |

# TABLE 44.

### Log. Sines, Tangents, and Secants.

0°                                                                                           179°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. 1'. | Cosecant. | Tangent. | Diff. 1'. | Cotangent. | Secant. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 12 0 0 | 0 0 0 | Inf. neg. | | Infinite. | Inf. neg. | | Infinite. | 10.00000 | 10.00000 | 60 |
| 1 | 11 59 52 | 0 8 | 6.46373 | 30103 | 13.53627 | 6.46373 | 30103 | 13.53627 | .00000 | 00000 | 59 |
| 2 | 59 44 | 0 16 | 76476 | 17609 | 23524 | 76476 | 17609 | 23524 | 00000 | 00000 | 58 |
| 3 | 59 36 | 0 24 | 94085 | 12494 | 05915 | 94085 | 12494 | 05915 | 00000 | 00000 | 57 |
| 4 | 59 28 | 0 32 | 7.06579 | 9691 | 12.93421 | 7.06579 | 9691 | 12.93421 | 00000 | 00000 | 56 |
| 5 | 11 59 20 | 0 0 40 | 7.16270 | 7918 | 12.83730 | 7.16270 | 7918 | 12.83730 | 10.00000 | 10.00000 | 55 |
| 6 | 59 12 | 0 48 | 24188 | 6694 | 75812 | 24188 | 6694 | 75812 | 00000 | 00000 | 54 |
| 7 | 59 4 | 0 56 | 30882 | 5800 | 69118 | 30882 | 5800 | 69118 | 00000 | 00000 | 53 |
| 8 | 58 56 | 1 4 | 36682 | 5115 | 63318 | 36682 | 5115 | 63318 | 00000 | 00000 | 52 |
| 9 | 58 48 | 1 12 | 41797 | 4576 | 58203 | 41797 | 4576 | 58203 | 00000 | 00000 | 51 |
| 10 | 11 58 40 | 0 1 20 | 7.46373 | 4139 | 12.53627 | 7.46373 | 4139 | 12.53627 | 10.00000 | 10.00000 | 50 |
| 11 | 58 32 | 1 28 | 50512 | 3779 | 49488 | 50512 | 3779 | 49488 | 00000 | 00000 | 49 |
| 12 | 58 24 | 1 36 | 54291 | 3476 | 45709 | 54291 | 3476 | 45709 | 00000 | 00000 | 48 |
| 13 | 58 16 | 1 44 | 57767 | 3218 | 42233 | 57767 | 3219 | 42233 | 00000 | 00000 | 47 |
| 14 | 58 8 | 1 52 | 60985 | 2997 | 39015 | 60986 | 2996 | 39014 | 00000 | 00000 | 46 |
| 15 | 11 58 0 | 0 2 0 | 7.63982 | 2802 | 12.36018 | 7.63982 | 2803 | 12.36018 | 10.00000 | 10.00000 | 45 |
| 16 | 57 52 | 2 8 | 66785 | 2633 | 33216 | 66785 | 2633 | 33215 | 00000 | 00000 | 44 |
| 17 | 57 44 | 2 16 | 69417 | 2483 | 30583 | 69418 | 2482 | 30582 | 00001 | 9.99999 | 43 |
| 18 | 57 36 | 2 24 | 71900 | 2348 | 28100 | 71900 | 2348 | 28100 | 00001 | 99999 | 42 |
| 19 | 57 28 | 2 32 | 74248 | 2227 | 25752 | 74248 | 2228 | 25752 | 00001 | 99999 | 41 |
| 20 | 11 57 20 | 0 2 40 | 7.76475 | 2119 | 12.23525 | 7.76476 | 2119 | 12.23524 | 10.00001 | 9.99999 | 40 |
| 21 | 57 12 | 2 48 | 78594 | 2021 | 21406 | 78595 | 2020 | 21405 | 00001 | 99999 | 39 |
| 22 | 57 4 | 2 56 | 80615 | 1930 | 19385 | 80615 | 1931 | 19385 | 00001 | 99999 | 38 |
| 23 | 56 56 | 3 4 | 82545 | 1848 | 17455 | 82546 | 1848 | 17454 | 00001 | 99999 | 37 |
| 24 | 56 48 | 3 12 | 84393 | 1773 | 15607 | 84394 | 1773 | 15606 | 00001 | 99999 | 36 |
| 25 | 11 56 40 | 0 3 20 | 7.86166 | 1704 | 12.13834 | 7.86167 | 1704 | 12.13833 | 10.00001 | 9.99999 | 35 |
| 26 | 56 32 | 3 28 | 87870 | 1639 | 12130 | 87871 | 1639 | 12129 | 00001 | 99999 | 34 |
| 27 | 56 24 | 3 36 | 89509 | 1579 | 10491 | 89510 | 1579 | 10490 | 00001 | 99999 | 33 |
| 28 | 56 16 | 3 44 | 91088 | 1524 | 08912 | 91089 | 1524 | 08911 | 00001 | 99999 | 32 |
| 29 | 56 8 | 3 52 | 92612 | 1472 | 07388 | 92613 | 1473 | 07387 | 00002 | 99998 | 31 |
| 30 | 11 56 0 | 0 4 0 | 7.94084 | 1424 | 12.05916 | 7.94084 | 1424 | 12.05916 | 10.00002 | 9.99998 | 30 |
| 31 | 55 52 | 4 8 | 95508 | 1379 | 04492 | 95510 | 1379 | 04490 | 00002 | 99998 | 29 |
| 32 | 55 44 | 4 16 | 96887 | 1336 | 03113 | 96889 | 1336 | 03111 | 00002 | 99998 | 28 |
| 33 | 55 36 | 4 24 | 98223 | 1297 | 01777 | 98225 | 1297 | 01775 | 00002 | 99998 | 27 |
| 34 | 55 28 | 4 32 | 99520 | 1259 | 00480 | 99522 | 1259 | 00478 | 00002 | 99998 | 26 |
| 35 | 11 55 20 | 0 4 40 | 8.00779 | 1223 | 11.99221 | 8.00781 | 1223 | 11.99219 | 10.00002 | 9.99998 | 25 |
| 36 | 55 12 | 4 48 | 02002 | 1190 | 97998 | 02004 | 1190 | 97996 | 00002 | 99998 | 24 |
| 37 | 55 4 | 4 56 | 03192 | 1158 | 96808 | 03194 | 1159 | 96806 | 00003 | 99997 | 23 |
| 38 | 54 56 | 5 4 | 04350 | 1128 | 95650 | 04353 | 1128 | 95647 | 00003 | 99997 | 22 |
| 39 | 54 48 | 5 12 | 05478 | 1100 | 94522 | 05481 | 1100 | 94519 | 00003 | 99997 | 21 |
| 40 | 11 54 40 | 0 5 20 | 8.06578 | 1072 | 11.93422 | 8.06581 | 1072 | 11.93419 | 10.00003 | 9.99997 | 20 |
| 41 | 54 32 | 5 28 | 07650 | 1046 | 92350 | 07653 | 1047 | 92347 | 00003 | 99997 | 19 |
| 42 | 54 24 | 5 36 | 08696 | 1022 | 91304 | 08700 | 1022 | 91300 | 00003 | 99997 | 18 |
| 43 | 54 16 | 5 44 | 09718 | 999 | 90282 | 09722 | 998 | 90278 | 00003 | 99997 | 17 |
| 44 | 54 8 | 5 52 | 10717 | 976 | 89283 | 10720 | 976 | 89280 | 00004 | 99996 | 16 |
| 45 | 11 54 0 | 0 6 0 | 8.11693 | 954 | 11.88307 | 8.11696 | 955 | 11.88304 | 10.00004 | 9.99996 | 15 |
| 46 | 53 52 | 6 8 | 12647 | 934 | 87353 | 12651 | 934 | 87349 | 00004 | 99996 | 14 |
| 47 | 53 44 | 6 16 | 13581 | 914 | 86419 | 13585 | 915 | 86415 | 00004 | 99996 | 13 |
| 48 | 53 36 | 6 24 | 14495 | 896 | 85505 | 14500 | 895 | 85500 | 00004 | 99996 | 12 |
| 49 | 53 28 | 6 32 | 15391 | 877 | 84609 | 15395 | 878 | 84605 | 00004 | 99996 | 11 |
| 50 | 11 53 20 | 0 6 40 | 8.16268 | 860 | 11.83732 | 8.16273 | 860 | 11.83727 | 10.00005 | 9.99995 | 10 |
| 51 | 53 12 | 6 48 | 17128 | 843 | 82872 | 17133 | 843 | 82867 | 00005 | 99995 | 9 |
| 52 | 53 4 | 6 56 | 17971 | 827 | 82029 | 17976 | 828 | 82024 | 00005 | 99995 | 8 |
| 53 | 52 56 | 7 4 | 18798 | 812 | 81202 | 18804 | 812 | 81196 | 00005 | 99995 | 7 |
| 54 | 52 48 | 7 12 | 19610 | 797 | 80390 | 19616 | 797 | 80384 | 00005 | 99995 | 6 |
| 55 | 11 52 40 | 0 7 20 | 8.20407 | 782 | 11.79593 | 8.20413 | 782 | 11.79587 | 10.00006 | 9.99994 | 5 |
| 56 | 52 32 | 7 28 | 21189 | 769 | 78811 | 21195 | 769 | 78805 | 00006 | 99994 | 4 |
| 57 | 52 24 | 7 36 | 21958 | 755 | 78042 | 21964 | 756 | 78036 | 00006 | 99994 | 3 |
| 58 | 52 16 | 7 44 | 22713 | 743 | 77287 | 22720 | 742 | 77280 | 00006 | 99994 | 2 |
| 59 | 52 8 | 7 52 | 23456 | 730 | 76544 | 23462 | 730 | 76538 | 00006 | 99994 | 1 |
| 60 | 52 0 | 8 0 | 24186 | 717 | 75814 | 24192 | 718 | 75808 | 00007 | 99993 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. 1'. | Secant. | Cotangent. | Diff. 1'. | Tangent. | Cosecant. | Sine. | M. |

90°                                                                                            89°

TABLE 44. [Page 609

Log. Sines, Tangents, and Secants.

1°                                                                              178°

| M. | Hour A. M. | Hour P. M. | Sine | Diff. 1'. | Cosecant. | Tangent. | Diff. 1'. | Cotangent. | Secant. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 11 52 0 | 0 8 0 | 8. 24186 | 717 | 11. 75814 | 8. 24192 | 718 | 11. 75808 | 10. 00007 | 9. 99993 | 60 |
| 1 | 51 52 | 8 8 | 24903 | 706 | 75097 | 24910 | 706 | 75090 | 00007 | 99993 | 59 |
| 2 | 51 44 | 8 16 | 25609 | 695 | 74391 | 25616 | 696 | 74384 | 00007 | 99993 | 58 |
| 3 | 51 36 | 8 24 | 26304 | 684 | 73696 | 26312 | 684 | 73688 | 00007 | 99993 | 57 |
| 4 | 51 28 | 8 32 | 26988 | 673 | 73012 | 26996 | 673 | 73004 | 00008 | 99992 | 56 |
| 5 | 11 51 20 | 0 8 40 | 8. 27661 | 663 | 11. 72339 | 8. 27669 | 663 | 11. 72331 | 10. 00008 | 9. 99992 | 55 |
| 6 | 51 12 | 8 48 | 28324 | 653 | 71676 | 28332 | 654 | 71668 | 00008 | 99992 | 54 |
| 7 | 51 4 | 8 56 | 28977 | 644 | 71023 | 28986 | 643 | 71014 | 00008 | 99992 | 53 |
| 8 | 50 56 | 9 4 | 29621 | 634 | 70379 | 29629 | 634 | 70371 | 00008 | 99992 | 52 |
| 9 | 50 48 | 9 12 | 30255 | 624 | 69745 | 30263 | 625 | 69737 | 00009 | 99991 | 51 |
| 10 | 11 50 40 | 0 9 20 | 8. 30879 | 616 | 11. 69121 | 8. 30888 | 617 | 11. 69112 | 10. 00009 | 9. 99991 | 50 |
| 11 | 50 32 | 9 28 | 31495 | 608 | 68505 | 31505 | 607 | 68495 | 00009 | 99991 | 49 |
| 12 | 50 24 | 9 36 | 32103 | 599 | 67897 | 32112 | 599 | 67888 | 00010 | 99990 | 48 |
| 13 | 50 16 | 9 44 | 32702 | 590 | 67298 | 32711 | 591 | 67289 | 00010 | 99990 | 47 |
| 14 | 50 8 | 9 52 | 33292 | 583 | 66708 | 33302 | 584 | 66698 | 00010 | 99990 | 46 |
| 15 | 11 50 0 | 0 10 0 | 8. 33875 | 575 | 11. 66125 | 8. 33886 | 575 | 11. 66114 | 10. 00010 | 9. 99990 | 45 |
| 16 | 49 52 | 10 8 | 34450 | 568 | 65550 | 34461 | 568 | 65539 | 00011 | 99989 | 44 |
| 17 | 49 44 | 10 16 | 35018 | 560 | 64982 | 35029 | 561 | 64971 | 00011 | 99989 | 43 |
| 18 | 49 36 | 10 24 | 35578 | 553 | 64422 | 35590 | 553 | 64410 | 00011 | 99989 | 42 |
| 19 | 49 28 | 10 32 | 36131 | 547 | 63869 | 36143 | 546 | 63857 | 00011 | 99989 | 41 |
| 20 | 11 49 20 | 0 10 40 | 8. 36678 | 539 | 11. 63322 | 8. 36689 | 540 | 11. 63311 | 10. 00012 | 9. 99988 | 40 |
| 21 | 49 12 | 10 48 | 37217 | 533 | 62783 | 37229 | 533 | 62771 | 00012 | 99988 | 39 |
| 22 | 49 4 | 10 56 | 37750 | 526 | 62250 | 37762 | 527 | 62238 | 00012 | 99988 | 38 |
| 23 | 48 56 | 11 4 | 38276 | 520 | 61724 | 38289 | 520 | 61711 | 00013 | 99987 | 37 |
| 24 | 48 48 | 11 12 | 38796 | 514 | 61204 | 38809 | 514 | 61191 | 00013 | 99987 | 36 |
| 25 | 11 48 40 | 0 11 20 | 8. 39310 | 508 | 11. 60690 | 8. 39323 | 509 | 11. 60677 | 10. 00013 | 9. 99987 | 35 |
| 26 | 48 32 | 11 28 | 39818 | 502 | 60182 | 39832 | 502 | 60168 | 00014 | 99986 | 34 |
| 27 | 48 24 | 11 36 | 40320 | 496 | 59680 | 40334 | 496 | 59666 | 00014 | 99986 | 33 |
| 28 | 48 16 | 11 44 | 40816 | 491 | 59184 | 40830 | 491 | 59170 | 00014 | 99986 | 32 |
| 29 | 48 8 | 11 52 | 41307 | 485 | 58693 | 41321 | 486 | 58679 | 00015 | 99985 | 31 |
| 30 | 11 48 0 | 0 12 0 | 8. 41792 | 480 | 11. 58208 | 8. 41807 | 480 | 11. 58193 | 10. 00015 | 9. 99985 | 30 |
| 31 | 47 52 | 12 8 | 42272 | 474 | 57728 | 42287 | 475 | 57713 | 00015 | 99985 | 29 |
| 32 | 47 44 | 12 16 | 42746 | 470 | 57254 | 42762 | 470 | 57238 | 00016 | 99984 | 28 |
| 33 | 47 36 | 12 24 | 43216 | 464 | 56784 | 43232 | 464 | 56768 | 00016 | 99984 | 27 |
| 34 | 47 28 | 12 32 | 43680 | 459 | 56320 | 43696 | 460 | 56304 | 00016 | 99984 | 26 |
| 35 | 11 47 20 | 0 12 40 | 8. 44139 | 455 | 11. 55861 | 8. 44156 | 455 | 11. 55844 | 10. 00017 | 9. 99983 | 25 |
| 36 | 47 12 | 12 48 | 44594 | 450 | 55406 | 44611 | 450 | 55389 | 00017 | 99983 | 24 |
| 37 | 47 4 | 12 56 | 45044 | 445 | 54956 | 45061 | 446 | 54939 | 00017 | 99983 | 23 |
| 38 | 46 56 | 13 4 | 45489 | 441 | 54511 | 45507 | 441 | 54493 | 00018 | 99982 | 22 |
| 39 | 46 48 | 13 12 | 45930 | 436 | 54070 | 45948 | 437 | 54052 | 00018 | 99982 | 21 |
| 40 | 11 46 40 | 0 13 20 | 8. 46366 | 433 | 11. 53634 | 8. 46385 | 432 | 11. 53615 | 10. 00018 | 9. 99982 | 20 |
| 41 | 46 32 | 13 28 | 46799 | 427 | 53201 | 46817 | 428 | 53183 | 00019 | 99981 | 19 |
| 42 | 46 24 | 13 36 | 47226 | 424 | 52774 | 47245 | 424 | 52755 | 00019 | 99981 | 18 |
| 43 | 46 16 | 13 44 | 47650 | 419 | 52350 | 47669 | 420 | 52331 | 00019 | 99981 | 17 |
| 44 | 46 8 | 13 52 | 48069 | 416 | 51931 | 48089 | 416 | 51911 | 00020 | 99980 | 16 |
| 45 | 11 46 0 | 0 14 0 | 8. 48485 | 411 | 11. 51515 | 8. 48505 | 412 | 11. 51495 | 10. 00020 | 9. 99980 | 15 |
| 46 | 45 52 | 14 8 | 48896 | 408 | 51104 | 48917 | 408 | 51083 | 00021 | 99979 | 14 |
| 47 | 45 44 | 14 16 | 49304 | 404 | 50696 | 49325 | 404 | 50675 | 00021 | 99979 | 13 |
| 48 | 45 36 | 14 24 | 49708 | 400 | 50292 | 49729 | 401 | 50271 | 00021 | 99979 | 12 |
| 49 | 45 28 | 14 32 | 50108 | 396 | 49892 | 50130 | 397 | 49870 | 00022 | 99978 | 11 |
| 50 | 11 45 20 | 0 14 40 | 8. 50504 | 393 | 11. 49496 | 8. 50527 | 393 | 11. 49473 | 10. 00022 | 9. 99978 | 10 |
| 51 | 45 12 | 14 48 | 50897 | 390 | 49103 | 50920 | 390 | 49080 | 00023 | 99977 | 9 |
| 52 | 45 4 | 14 56 | 51287 | 386 | 48713 | 51310 | 386 | 48690 | 00023 | 99977 | 8 |
| 53 | 44 56 | 15 4 | 51673 | 382 | 48327 | 51696 | 383 | 48304 | 00023 | 99977 | 7 |
| 54 | 44 48 | 15 12 | 52055 | 379 | 47945 | 52079 | 380 | 47921 | 00024 | 99976 | 6 |
| 55 | 11 44 40 | 0 15 20 | 8. 52434 | 376 | 11. 47566 | 8. 52459 | ·376 | 11. 47541 | 10. 00024 | 9. 99976 | 5 |
| 56 | 44 32 | 15 28 | 52810 | 373 | 47190 | 52835 | 373 | 47165 | 00025 | 99975 | 4 |
| 57 | 44 24 | 15 36 | 53183 | 369 | 46817 | 53208 | 370 | 46792 | 00025 | 99975 | 3 |
| 58 | 44 16 | 15 44 | 53552 | 367 | 46448 | 53578 | 367 | 46422 | 00026 | 99974 | 2 |
| 59 | 44 8 | 15 52 | 53919 | 363 | 46081 | 53945 | 363 | 46055 | 00026 | 99974 | 1 |
| 60 | 44 0 | 16 0 | 54282 | 360 | 45718 | 54308 | 361 | 45692 | 00026 | 99974 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. 1'. | Secant. | Cotangent. | Diff. 1'. | Tangent. | Cosecant. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|

91°                                                                              88°

# TABLE 44.

### Log. Sines, Tangents, and Secants.

2°                                                                177°

| M. | Hour A.M. | Hour P.M. | Sine. | Diff. 1'. | Cosecant. | Tangent. | Diff. 1'. | Cotangent. | Secant. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 11 44 0 | 0 16 0 | 8. 54282 | 360 | 11. 45718 | 8. 54308 | 361 | 11. 45692 | 10. 00026 | 9. 99974 | 60 |
| 1 | 43 52 | 16 8 | 54642 | 357 | 45358 | 54669 | 358 | 45331 | 00027 | 99973 | 59 |
| 2 | 43 44 | 16 16 | 54999 | 355 | 45001 | 55027 | 355 | 44973 | 00027 | 99973 | 58 |
| 3 | 43 36 | 16 24 | 55354 | 351 | 44646 | 55382 | 352 | 44618 | 00028 | 99972 | 57 |
| 4 | 43 28 | 16 32 | 55705 | 349 | 44295 | 55734 | 349 | 44266 | 00028 | 99972 | 56 |
| 5 | 11 43 20 | 0 16 40 | 8. 56054 | 346 | 11. 43946 | 8. 56083 | 346 | 11. 43917 | 10. 00029 | 9. 99971 | 55 |
| 6 | 43 12 | 16 48 | 56400 | 343 | 43600 | 56429 | 344 | 43571 | 00029 | 99971 | 54 |
| 7 | 43. 4 | 16 56 | 56743 | 341 | 43257 | 56773 | 341 | 43227 | 00030 | 99970 | 53 |
| 8 | 42 56 | 17 4 | 57084 | 337 | 42916 | 57114 | 338 | 42886 | 00030 | 99970 | 52 |
| 9 | 42 48 | 17 12 | 57421 | 336 | 42579 | 57452 | 336 | 42548 | 00031 | 99969 | 51 |
| 10 | 11 42 40 | 0 17 20 | 8. 57757 | 332 | 11. 42243 | 8. 57788 | 333 | 11. 42212 | 10. 00031 | 9. 99969 | 50 |
| 11 | 42 32 | 17 28 | 58089 | 330 | 41911 | 58121 | 330 | 41879 | 00032 | 99968 | 49 |
| 12 | 42 24 | 17 36 | 58419 | 328 | 41581 | 58451 | 328 | 41549 | 00032 | 99968 | 48 |
| 13 | 42 16 | 17 44 | 58747 | 325 | 41253 | 58779 | 326 | 41221 | 00033 | 99967 | 47 |
| 14 | 42 8 | 17 52 | 59072 | 323 | 40928 | 59105 | 323 | 40895 | 00033 | 99967 | 46 |
| 15 | 11 42 0 | 0 18 0 | 8. 59395 | 320 | 11. 40605 | 8. 59428 | 321 | 11. 40572 | 10. 00033 | 9. 99967 | 45 |
| 16 | 41 52 | 18 8 | 59715 | 318 | 40285 | 59749 | 319 | 40251 | 00034 | 99966 | 44 |
| 17 | 41 44 | 18 16 | 60033 | 316 | 39967 | 60068 | 316 | 39932 | 00034 | 99966 | 43 |
| 18 | 41 36 | 18 24 | 60349 | 313 | 39651 | 60384 | 314 | 39616 | 00035 | 99965 | 42 |
| 19 | 41 28 | 18 32 | 60662 | 311 | 39338 | 60698 | 311 | 39302 | 00036 | 99964 | 41 |
| 20 | 11 41 20 | 0 18 40 | 8. 60973 | 309 | 11. 39027 | 8. 61009 | 310 | 11. 38991 | 10. 00036 | 9. 99964 | 40 |
| 21 | 41 12 | 18 48 | 61282 | 307 | 38718 | 61319 | 307 | 38681 | 00037 | 99963 | 39 |
| 22 | 41 4 | 18 56 | 61589 | 305 | 38411 | 61626 | 305 | 38374 | 00037 | 99963 | 38 |
| 23 | 40 56 | 19 4 | 61894 | 302 | 38106 | 61931 | 303 | 38069 | 00038 | 99962 | 37 |
| 24 | 40 48 | 19 12 | 62196 | 301 | 37804 | 62234 | 301 | 37766 | 00038 | 99962 | 36 |
| 25 | 11 40 40 | 0 19 20 | 8. 62497 | 298 | 11. 37503 | 8. 62535 | 299 | 11. 37465 | 10. 00039 | 9. 99961 | 35 |
| 26 | 40 32 | 19 28 | 62795 | 296 | 37205 | 62834 | 297 | 37166 | 00039 | 99961 | 34 |
| 27 | 40 24 | 19 36 | 63091 | 294 | 36909 | 63131 | 295 | 36869 | 00040 | 99960 | 33 |
| 28 | 40 16 | 19 44 | 63385 | 293 | 36615 | 63426 | 292 | 36574 | 00040 | 99960 | 32 |
| 29 | 40 8 | 19 52 | 63678 | 290 | 36322 | 63718 | 291 | 36282 | 00041 | 99959 | 31 |
| 30 | 11 40 0 | 0 20 0 | 8. 63968 | 288 | 11. 36032 | 8. 64009 | 289 | 11. 35991 | 10. 00041 | 9. 99959 | 30 |
| 31 | 39 52 | 20 8 | 64256 | 287 | 35744 | 64298 | 287 | 35702 | 00042 | 99958 | 29 |
| 32 | 39 44 | 20 16 | 64543 | 284 | 35457 | 64585 | 285 | 35415 | 00042 | 99958 | 28 |
| 33 | 39 36 | 20 24 | 64827 | 283 | 35173 | 64870 | 284 | 35130 | 00043 | 99957 | 27 |
| 34 | 39 28 | 20 32 | 65110 | 281 | 34890 | 65154 | 281 | 34846 | 00044 | 99956 | 26 |
| 35 | 11 39 20 | 0 20 40 | 8. 65391 | 279 | 11. 34609 | 8. 65435 | 280 | 11. 34565 | 10. 00044 | 9. 99956 | 25 |
| 36 | 39 12 | 20 48 | 65670 | 277 | 34330 | 65715 | 278 | 34285 | 00045 | 99955 | 24 |
| 37 | 39 4 | 20 56 | 65947 | 276 | 34053 | 65993 | 276 | 34007 | 00045 | 99955 | 23 |
| 38 | 38 56 | 21 4 | 66223 | 274 | 33777 | 66269 | 274 | 33731 | 00046 | 99954 | 22 |
| 39 | 38 48 | 21 12 | 66497 | 272 | 33503 | 66543 | 273 | 33457 | 00046 | 99954 | 21 |
| 40 | 11 38 40 | 0 21 20 | 8. 66769 | 270 | 11. 33231 | 8. 66816 | 271 | 11. 33184 | 10. 00047 | 9. 99953 | 20 |
| 41 | 38 32 | 21 28 | 67039 | 269 | 32961 | 67087 | 269 | 32913 | 00048 | 99952 | 19 |
| 42 | 38 24 | 21 36 | 67308 | 267 | 32692 | 67356 | 268 | 32644 | 00048 | 99952 | 18 |
| 43 | 38 16 | 21 44 | 67575 | 266 | 32425 | 67624 | 266 | 32376 | 00049 | 99951 | 17 |
| 44 | 38 8 | 21 52 | 67841 | 263 | 32159 | 67890 | 264 | 32110 | 00049 | 99951 | 16 |
| 45 | 11 38 0 | 0 22 0 | 8. 68104 | 263 | 11. 31896 | 8. 68154 | 263 | 11. 31846 | 10. 00050 | 9. 99950 | 15 |
| 46 | 37 52 | 22 8 | 68367 | 260 | 31633 | 68417 | 261 | 31583 | 00051 | 99949 | 14 |
| 47 | 37 44 | 22 16 | 68627 | 259 | 31373 | 68678 | 260 | 31322 | 00051 | 99949 | 13 |
| 48 | 37 36 | 22 24 | 68886 | 258 | 31114 | 68938 | 258 | 31062 | 00052 | 99948 | 12 |
| 49 | 37 28 | 22 32 | 69144 | 256 | 30856 | 69196 | 257 | 30804 | 00052 | 99948 | 11 |
| 50 | 11 37 20 | 0 22 40 | 8. 69400 | 254 | 11. 30600 | 8. 69453 | 255 | 11. 30547 | 10. 00053 | 9. 99947 | 10 |
| 51 | 37 12 | 22 48 | 69654 | 253 | 30346 | 69708 | 254 | 30292 | 00054 | 99946 | 9 |
| 52 | 37 4 | 22 56 | 69907 | 252 | 30093 | 69962 | 252 | 30038 | 00054 | 99946 | 8 |
| 53 | 36 56 | 23 4 | 70159 | 250 | 29841 | 70214 | 251 | 29786 | 00055 | 99945 | 7 |
| 54 | 36 48 | 23 12 | 70409 | 249 | 29591 | 70465 | 249 | 29535 | 00056 | 99944 | 6 |
| 55 | 11 36 40 | 0 23 20 | 8. 70658 | 247 | 11. 29342 | 8. 70714 | 248 | 11. 29286 | 10. 00056 | 9. 99944 | 5 |
| 56 | 36 32 | 23 28 | 70905 | 246 | 29095 | 70962 | 246 | 29038 | 00057 | 99943 | 4 |
| 57 | 36 24 | 23 36 | 71151 | 244 | 28849 | 71208 | 245 | 28792 | 00058 | 99942 | 3 |
| 58 | 36 16 | 23 44 | 71395 | 243 | 28605 | 71453 | 244 | 28547 | 00058 | 99942 | 2 |
| 59 | 36 8 | 23 52 | 71638 | 242 | 28362 | 71697 | 243 | 28303 | 00059 | 99941 | 1 |
| 60 | 36 0 | 24 0 | 71880 | 240 | 28120 | 71940 | 241 | 28060 | 00060 | 99940 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. 1'. | Secant. | Cotangent. | Diff. 1'. | Tangent. | Cosecant. | Sine. | M. |

TABLE 44.    [Page 611

Log. Sines, Tangents, and Secants.

3°  176°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. 1'. | Cosecant. | Tangent. | Diff. 1'. | Cotangent. | Secant. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 11 36 0 | 0 24 0 | 8. 71880 | 240 | 11. 28120 | 8. 71940 | 241 | 11. 28060 | 10. 00060 | 9. 99940 | 60 |
| 1 | 35 52 | 24 8 | 72120 | 239 | 27880 | 72181 | 239 | 27819 | 00060 | 99940 | 59 |
| 2 | 35 44 | 24 16 | 72359 | 238 | 27641 | 72420 | 239 | 27580 | 00061 | 99939 | 58 |
| 3 | 35 36 | 24 24 | 72597 | 237 | 27403 | 72659 | 237 | 27341 | 00062 | 99938 | 57 |
| 4 | 35 28 | 24 32 | 72834 | 235 | 27166 | 72896 | 236 | 27104 | 00062 | 99938 | 56 |
| 5 | 11 35 20 | 0 24 40 | 8. 73069 | 234 | 11. 26931 | 8. 73132 | 234 | 11. 26868 | 10. 00063 | 9. 99937 | 55 |
| 6 | 35 12 | 24 48 | 73303 | 232 | 26697 | 73366 | 234 | 26634 | 00064 | 99936 | 54 |
| 7 | 35 4 | 24 56 | 73535 | 232 | 26465 | 73600 | 232 | 26400 | 00064 | 99936 | 53 |
| 8 | 34 56 | 25 4 | 73767 | 230 | 26233 | 73832 | 231 | 26168 | 00065 | 99935 | 52 |
| 9 | 34 48 | 25 12 | 73997 | 229 | 26003 | 74063 | 229 | 25937 | 00066 | 99934 | 51 |
| 10 | 11 34 40 | 0 25 20 | 8. 74226 | 228 | 11. 25774 | 8. 74292 | 229 | 11. 25708 | 10. 00066 | 9. 99934 | 50 |
| 11 | 34 32 | 25 28 | 74454 | 226 | 25546 | 74521 | 227 | 25479 | 00067 | 99933 | 49 |
| 12 | 34 24 | 25 36 | 74680 | 226 | 25320 | 74748 | 226 | 25252 | 00068 | 99932 | 48 |
| 13 | 34 16 | 25 44 | 74906 | 224 | 25094 | 74974 | 225 | 25026 | 00068 | 99932 | 47 |
| 14 | 34 8 | 25 52 | 75130 | 223 | 24870 | 75199 | 224 | 24801 | 00069 | 99931 | 46 |
| 15 | 11 34 0 | 0 26 0 | 8. 75353 | 222 | 11. 24647 | 8. 75423 | 222 | 11. 24577 | 10. 00070 | 9. 99930 | 45 |
| 16 | 33 52 | 26 8 | 75575 | 220 | 24425 | 75645 | 222 | 24355 | 00071 | 99929 | 44 |
| 17 | 33 44 | 26 16 | 75795 | 220 | 24205 | 75867 | 220 | 24133 | 00071 | 99929 | 43 |
| 18 | 33 36 | 26 24 | 76015 | 219 | 23985 | 76087 | 219 | 23913 | 00072 | 99928 | 42 |
| 19 | 33 28 | 26 32 | 76234 | 217 | 23766 | 76306 | 219 | 23694 | 00073 | 99927 | 41 |
| 20 | 11 33 20 | 0 26 40 | 8. 76451 | 216 | 11. 23549 | 8. 76525 | 217 | 11. 23475 | 10. 00074 | 9. 99926 | 40 |
| 21 | 33 12 | 26 48 | 76667 | 216 | 23333 | 76742 | 216 | 23258 | 00074 | 99926 | 39 |
| 22 | 33 4 | 26 56 | 76883 | 214 | 23117 | 76958 | 215 | 23042 | 00075 | 99925 | 38 |
| 23 | 32 56 | 27 4 | 77097 | 213 | 22903 | 77173 | 214 | 22827 | 00076 | 99924 | 37 |
| 24 | 32 48 | 27 12 | 77310 | 212 | 22690 | 77387 | 213 | 22613 | 00077 | 99923 | 36 |
| 25 | 11 32 40 | 0 27 20 | 8. 77522 | 211 | 11. 22478 | 8. 77600 | 211 | 11. 22400 | 10. 00077 | 9. 99923 | 35 |
| 26 | 32 32 | 27 28 | 77733 | 210 | 22267 | 77811 | 211 | 22189 | 00078 | 99922 | 34 |
| 27 | 32 24 | 27 36 | 77943 | 209 | 22057 | 78022 | 210 | 21978 | 00079 | 99921 | 33 |
| 28 | 32 16 | 27 44 | 78152 | 208 | 21848 | 78232 | 209 | 21768 | 00080 | 99920 | 32 |
| 29 | 32 8 | 27 52 | 78360 | 208 | 21640 | 78441 | 208 | 21559 | 00080 | 99920 | 31 |
| 30 | 11 32 0 | 0 28 0 | 8. 78568 | 206 | 11. 21432 | 8. 78649 | 206 | 11. 21351 | 10. 00081 | 9. 99919 | 30 |
| 31 | 31 52 | 28 8 | 78774 | 205 | 21226 | 78855 | 206 | 21145 | 00082 | 99918 | 29 |
| 32 | 31 44 | 28 16 | 78979 | 204 | 21021 | 79061 | 205 | 20939 | 00083 | 99917 | 28 |
| 33 | 31 36 | 28 24 | 79183 | 203 | 20817 | 79266 | 204 | 20734 | 00083 | 99917 | 27 |
| 34 | 31 28 | 28 32 | 79386 | 202 | 20614 | 79470 | 203 | 20530 | 00084 | 99916 | 26 |
| 35 | 11 31 20 | 0 28 40 | 8. 79588 | 201 | 11. 20412 | 8. 79673 | 202 | 11. 20327 | 10. 00085 | 9. 99915 | 25 |
| 36 | 31 12 | 28 48 | 79789 | 201 | 20211 | 79875 | 201 | 20125 | 00086 | 99914 | 24 |
| 37 | 31 4 | 28 56 | 79990 | 199 | 20010 | 80076 | 201 | 19924 | 00087 | 99913 | 23 |
| 38 | 30 56 | 29 4 | 80189 | 199 | 19811 | 80277 | 199 | 19723 | 00087 | 99913 | 22 |
| 39 | 30 48 | 29 12 | 80388 | 197 | 19612 | 80476 | 198 | 19524 | 00088 | 99912 | 21 |
| 40 | 11 30 40 | 0 29 20 | 8. 80585 | 197 | 11. 19415 | 8. 80674 | 198 | 11. 19326 | 10. 00089 | 9. 99911 | 20 |
| 41 | 30 32 | 29 28 | 80782 | 196 | 19218 | 80872 | 196 | 19128 | 00090 | 99910 | 19 |
| 42 | 30 24 | 29 36 | 80978 | 195 | 19022 | 81068 | 196 | 18932 | 00091 | 99909 | 18 |
| 43 | 30 16 | 29 44 | 81173 | 194 | 18827 | 81264 | 195 | 18736 | 00091 | 99909 | 17 |
| 44 | 30 8 | 29 52 | 81367 | 193 | 18633 | 81459 | 194 | 18541 | 00092 | 99908 | 16 |
| 45 | 11 30 0 | 0 30 0 | 8. 81560 | 192 | 11. 18440 | 8. 81653 | 193 | 11. 18347 | 10. 00093 | 9. 99907 | 15 |
| 46 | 29 52 | 30 8 | 81752 | 192 | 18248 | 81846 | 192 | 18154 | 00094 | 99906 | 14 |
| 47 | 29 44 | 30 16 | 81944 | 190 | 18056 | 82038 | 192 | 17962 | 00095 | 99905 | 13 |
| 48 | 29 36 | 30 24 | 82134 | 190 | 17866 | 82230 | 190 | 17770 | 00096 | 99904 | 12 |
| 49 | 29 28 | 30 32 | 82324 | 189 | 17676 | 82420 | 190 | 17580 | 00096 | 99904 | 11 |
| 50 | 11 29 20 | 0 30 40 | 8. 82513 | 188 | 11. 17487 | 8. 82610 | 189 | 11. 17390 | 10. 00097 | 9. 99903 | 10 |
| 51 | 29 12 | 30 48 | 82701 | 187 | 17299 | 82799 | 188 | 17201 | 00098 | 99902 | 9 |
| 52 | 29 4 | 30 56 | 82888 | 187 | 17112 | 82987 | 188 | 17013 | 00099 | 99901 | 8 |
| 53 | 28 56 | 31 4 | 83075 | 186 | 16925 | 83175 | 186 | 16825 | 00100 | 99900 | 7 |
| 54 | 28 48 | 31 12 | 83261 | 185 | 16739 | 83361 | 186 | 16639 | 00101 | 99899 | 6 |
| 55 | 11 28 40 | 0 31 20 | 8. 83446 | 184 | 11. 16554 | 8. 83547 | 185 | 11. 16453 | 10. 00102 | 9. 99898 | 5 |
| 56 | 28 32 | 31 28 | 83630 | 183 | 16370 | 83732 | 184 | 16268 | 00102 | 99898 | 4 |
| 57 | 28 24 | 31 36 | 83813 | 183 | 16187 | 83916 | 184 | 16084 | 00103 | 99897 | 3 |
| 58 | 28 16 | 31 44 | 83996 | 181 | 16004 | 84100 | 182 | 15900 | 00104 | 99896 | 2 |
| 59 | 28 8 | 31 52 | 84177 | 181 | 15823 | 84282 | 182 | 15718 | 00105 | 99895 | 1 |
| 60 | 28 0 | 32 0 | 84358 | 181 | 15642 | 84464 | 182 | 15536 | 00106 | 99894 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. 1'. | Secant. | Cotangent. | Diff. 1'. | Tangent. | Cosecant. | Sine | M. |

93°  86°

# TABLE 44.

### Log. Sines, Tangents, and Secants.

4°  175°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff.1'. | Cosecant. | Tangent. | Diff.1'. | Cotangent. | Secant. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 11 28 0 | 0 32 0 | 8. 84358 | 181 | 11. 15642 | 8. 84464 | 182 | 11. 15536 | 10. 00106 | 9. 99894 | 60 |
| 1 | 27 52 | 32 8 | 84539 | 179 | 15461 | 84646 | 180 | 15354 | 00107 | 99893 | 59 |
| 2 | 27 44 | 32 16 | 84718 | 179 | 15282 | 84826 | 180 | 15174 | 00108 | 99892 | 58 |
| 3 | 27 36 | 32 24 | 84897 | 178 | 15103 | 85006 | 179 | 14994 | 00109 | 99891 | 57 |
| 4 | 27 28 | 32 32 | 85075 | 177 | 14925 | 85185 | 178 | 14815 | 00109 | 99891 | 56 |
| 5 | 11 27 20 | 0 32 40 | 8. 85252 | 177 | 11. 14748 | 8. 85363 | 177 | 11. 14637 | 10. 00110 | 9. 99890 | 55 |
| 6 | 27 12 | 32 48 | 85429 | 176 | 14571 | 85540 | 177 | 14460 | 00111 | 99889 | 54 |
| 7 | 27 4 | 32 56 | 85605 | 175 | 14395 | 85717 | 176 | 14283 | 00112 | 99888 | 53 |
| 8 | 26 56 | 33 4 | 85780 | 175 | 14220 | 85893 | 176 | 14107 | 00113 | 99887 | 52 |
| 9 | 26 48 | 33 12 | 85955 | 173 | 14045 | 86069 | 174 | 13931 | 00114 | 99886 | 51 |
| 10 | 11 26 40 | 0 33 20 | 8. 86128 | 173 | 11. 13872 | 8. 86243 | 174 | 11. 13757 | 10. 00115 | 9. 99885 | 50 |
| 11 | 26 32 | 33 28 | 86301 | 173 | 13699 | 86417 | 174 | 13583 | 00116 | 99884 | 49 |
| 12 | 26 24 | 33 36 | 86474 | 171 | 13526 | 86591 | 172 | 13409 | 00117 | 99883 | 48 |
| 13 | 26 16 | 33 44 | 86645 | 171 | 13355 | 86763 | 172 | 13237 | 00118 | 99882 | 47 |
| 14 | 26 8 | 33 52 | 86816 | 171 | 13184 | 86935 | 171 | 13065 | 00119 | 99881 | 46 |
| 15 | 11 26 0 | 0 34 0 | 8. 86987 | 169 | 11. 13013 | 8. 87106 | 171 | 11. 12894 | 10. 00120 | 9. 99880 | 45 |
| 16 | 25 52 | 34 8 | 87156 | 169 | 12844 | 87277 | 170 | 12723 | 00121 | 99879 | 44 |
| 17 | 25 44 | 34 16 | 87325 | 169 | 12675 | 87447 | 169 | 12553 | 00121 | 99879 | 43 |
| 18 | 25 36 | 34 24 | 87494 | 167 | 12506 | 87616 | 169 | 12384 | 00122 | 99878 | 42 |
| 19 | 25 28 | 34 32 | 87661 | 168 | 12339 | 87785 | 168 | 12215 | 00123 | 99877 | 41 |
| 20 | 11 25 20 | 0 34 40 | 8. 87829 | 166 | 11. 12171 | 8. 87953 | 167 | 11. 12047 | 10. 00124 | 9. 99876 | 40 |
| 21 | 25 12 | 34 48 | 87995 | 166 | 12005 | 88120 | 167 | 11880 | 00125 | 99875 | 39 |
| 22 | 25 4 | 34 56 | 88161 | 165 | 11839 | 88287 | 166 | 11713 | 00126 | 99874 | 38 |
| 23 | 24 56 | 35 4 | 88326 | 164 | 11674 | 88453 | 165 | 11547 | 00127 | 99873 | 37 |
| 24 | 24 48 | 35 12 | 88490 | 164 | 11510 | 88618 | 165 | 11382 | 00128 | 99872 | 36 |
| 25 | 11 24 40 | 0 35 20 | 8. 88654 | 163 | 11. 11346 | 8. 88783 | 165 | 11. 11217 | 10. 00129 | 9. 99871 | 35 |
| 26 | 24 32 | 35 28 | 88817 | 163 | 11183 | 88948 | 163 | 11052 | 00130 | 99870 | 34 |
| 27 | 24 24 | 35 36 | 88980 | 162 | 11020 | 89111 | 163 | 10889 | 00131 | 99869 | 33 |
| 28 | 24 16 | 35 44 | 89142 | 162 | 10858 | 89274 | 163 | 10726 | 00132 | 99868 | 32 |
| 29 | 24 8 | 35 52 | 89304 | 160 | 10696 | 89437 | 161 | 10563 | 00133 | 99867 | 31 |
| 30 | 11 24 0 | 0 36 0 | 8. 89464 | 161 | 11. 10536 | 8. 89598 | 162 | 11. 10402 | 10. 00134 | 9. 99866 | 30 |
| 31 | 23 52 | 36 8 | 89625 | 159 | 10375 | 89760 | 160 | 10240 | 00135 | 99865 | 29 |
| 32 | 23 44 | 36 16 | 89784 | 159 | 10216 | 89920 | 160 | 10080 | 00136 | 99864 | 28 |
| 33 | 23 36 | 36 24 | 89943 | 159 | 10057 | 90080 | 160 | 09920 | 00137 | 99863 | 27 |
| 34 | 23 28 | 36 32 | 90102 | 158 | 09898 | 90240 | 159 | 09760 | 00138 | 99862 | 26 |
| 35 | 11 23 20 | 0 36 40 | 8. 90260 | 157 | 11. 09740 | 8. 90399 | 158 | 11. 09601 | 10. 00139 | 9. 99861 | 25 |
| 36 | 23 12 | 36 48 | 90417 | 157 | 09583 | 90557 | 158 | 09443 | 00140 | 99860 | 24 |
| 37 | 23 4 | 36 56 | 90574 | 156 | 09426 | 90715 | 157 | 09285 | 00141 | 99859 | 23 |
| 38 | 22 56 | 37 4 | 90730 | 155 | 09270 | 90872 | 157 | 09128 | 00142 | 99858 | 22 |
| 39 | 22 48 | 37 12 | 90885 | 155 | 09115 | 91029 | 156 | 08971 | 00143 | 99857 | 21 |
| 40 | 11 22 40 | 0 37 20 | 8. 91040 | 155 | 11. 08960 | 8. 91185 | 155 | 11. 08815 | 10. 00144 | 9. 99856 | 20 |
| 41 | 22 32 | 37 28 | 91195 | 154 | 08805 | 91340 | 155 | 08660 | 00145 | 99855 | 19 |
| 42 | 22 24 | 37 36 | 91349 | 153 | 08651 | 91495 | 155 | 08505 | 00146 | 99854 | 18 |
| 43 | 22 16 | 37 44 | 91502 | 153 | 08498 | 91650 | 153 | 08350 | 00147 | 99853 | 17 |
| 44 | 22 8 | 37 52 | 91655 | 152 | 08345 | 91803 | 154 | 08197 | 00148 | 99852 | 16 |
| 45 | 11 22 0 | 0 38 0 | 8. 91807 | 152 | 11. 08193 | 8. 91957 | 153 | 11. 08043 | 10. 00149 | 9. 99851 | 15 |
| 46 | 21 52 | 38 8 | 91959 | 151 | 08041 | 92110 | 152 | 07890 | 00150 | 99850 | 14 |
| 47 | 21 44 | 38 16 | 92110 | 151 | 07890 | 92262 | 152 | 07738 | 00152 | 99848 | 13 |
| 48 | 21 36 | 38 24 | 92261 | 150 | 07739 | 92414 | 151 | 07586 | 00153 | 99847 | 12 |
| 49 | 21 28 | 38 32 | 92411 | 150 | 07589 | 92565 | 151 | 07435 | 00154 | 99846 | 11 |
| 50 | 11 21 20 | 0 38 40 | 8. 92561 | 149 | 11. 07439 | 8. 92716 | 150 | 11. 07284 | 10. 00155 | 9. 99845 | 10 |
| 51 | 21 12 | 38 48 | 92710 | 149 | 07290 | 92866 | 150 | 07134 | 00156 | 99844 | 9 |
| 52 | 21 4 | 38 56 | 92859 | 148 | 07141 | 93016 | 149 | 06984 | 00157 | 99843 | 8 |
| 53 | 20 56 | 39 4 | 93007 | 147 | 06993 | 93165 | 148 | 06835 | 00158 | 99842 | 7 |
| 54 | 20 48 | 39 12 | 93154 | 147 | 06846 | 93313 | 149 | 06687 | 00159 | 99841 | 6 |
| 55 | 11 20 40 | 0 39 20 | 8. 93301 | 147 | 11. 06699 | 8. 93462 | 147 | 11. 06538 | 10. 00160 | 9. 99840 | 5 |
| 56 | 20 32 | 39 28 | 93448 | 146 | 06552 | 93609 | 147 | 06391 | 00161 | 99839 | 4 |
| 57 | 20 24 | 39 36 | 93594 | 146 | 06406 | 93756 | 147 | 06244 | 00162 | 99838 | 3 |
| 58 | 20 16 | 39 44 | 93740 | 145 | 06260 | 93903 | 146 | 06097 | 00163 | 99837 | 2 |
| 59 | 20 8 | 39 52 | 93885 | 145 | 06115 | 94049 | 146 | 05951 | 00164 | 99836 | 1 |
| 60 | 20 0 | 40 0 | 94030 | 144 | 05970 | 94195 | 145 | 05805 | 00166 | 99834 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff.1'. | Secant. | Cotangent. | Diff.1'. | Tangent. | Cosecant. | Sine. | M. |

94°  85°

## TABLE 44. [Page 613

Log. Sines, Tangents, and Secants.

5°     A     A     B     B     C     C     174°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 11 20 00 | 0 40 00 | 8.94030 | 0 | 11.05970 | 8.94195 | 0 | 11.05805 | 10.00166 | 0 | 9.99834 | 60 |
| 1 | 19 52 | 40 08 | 94174 | 2 | 05826 | 94340 | 2 | 05660 | 00167 | 0 | 99833 | 59 |
| 2 | 19 44 | 40 16 | 94317 | 4 | 05683 | 94485 | 4 | 05515 | 00168 | 0 | 99832 | 58 |
| 3 | 19 36 | 40 24 | 94461 | 7 | 05539 | 94630 | 7 | 05370 | 00169 | 0 | 99831 | 57 |
| 4 | 19 28 | 40 32 | 94603 | 9 | 05397 | 94773 | 9 | 05227 | 00170 | 0 | 99830 | 56 |
| 5 | 11 19 20 | 0 40 40 | 8.94746 | 11 | 11.05254 | 8.94917 | 11 | 11.05083 | 10.00171 | 0 | 9.99829 | 55 |
| 6 | 19 12 | 40 48 | 94887 | 13 | 05113 | 95060 | 13 | 04940 | 00172 | 0 | 99828 | 54 |
| 7 | 19 04 | 40 56 | 95029 | 15 | 04971 | 95202 | 15 | 04798 | 00173 | 0 | 99827 | 53 |
| 8 | 18 56 | 41 04 | 95170 | 18 | 04830 | 95344 | 18 | 04656 | 00175 | 0 | 99825 | 52 |
| 9 | 18 48 | 41 12 | 95310 | 20 | 04690 | 95486 | 20 | 04514 | 00176 | 0 | 99824 | 51 |
| 10 | 11 18 40 | 0 41 20 | 8.95450 | 22 | 11.04550 | 8.95627 | 22 | 11.04373 | 10.00177 | 0 | 9.99823 | 50 |
| 11 | 18 32 | 41 28 | 95589 | 24 | 04411 | 95767 | 24 | 04233 | 00178 | 0 | 99822 | 49 |
| 12 | 18 24 | 41 36 | 95728 | 26 | 04272 | 95908 | 27 | 04092 | 00179 | 0 | 99821 | 48 |
| 13 | 18 16 | 41 44 | 95867 | 29 | 04133 | 96047 | 29 | 03953 | 00180 | 0 | 99820 | 47 |
| 14 | 18 08 | 41 52 | 96005 | 31 | 03995 | 96187 | 31 | 03813 | 00181 | 0 | 99819 | 46 |
| 15 | 11 18 00 | 0 42 00 | 8.96143 | 33 | 11.03857 | 8.96325 | .33 | 11.03675 | 10.00183 | 0 | 9.99817 | 45 |
| 16 | 17 52 | 42 08 | 96280 | 35 | 03720 | 96464 | 35 | 03536 | 00184 | 0 | 99816 | 44 |
| 17 | 17 44 | 42 16 | 96417 | 37 | 03583 | 96602 | 38 | 03398 | 00185 | 0 | 99815 | 43 |
| 18 | 17 36 | 42 24 | 96553 | 39 | 03447 | 96739 | 40 | 03261 | 00186 | 0 | 99814 | 42 |
| 19 | 17 28 | 42 32 | 96689 | 42 | 03311 | 96877 | 42 | 03123 | 00187 | 0 | 99813 | 41 |
| 20 | 11 17 20 | 0 42 40 | 8.96825 | 44 | 11.03175 | 8.97013 | 44 | 11.02987 | 10.00188 | 0 | 9.99812 | 40 |
| 21 | 17 12 | 42 48 | 96960 | 46 | 03040 | 97150 | 46 | 02850 | 00190 | 0 | 99810 | 39 |
| 22 | 17 04 | 42 56 | 97095 | 48 | 02905 | 97285 | 49 | 02715 | 00191 | 0 | 99809 | 38 |
| 23 | 16 56 | 43 04 | 97229 | 50 | 02771 | 97421 | 51 | 02579 | 00192 | 0 | 99808 | 37 |
| 24 | 16 48 | 43 12 | 97363 | 53 | 02637 | 97556 | 53 | 02444 | 00193 | 0 | 99807 | 36 |
| 25 | 11 16 40 | 0 43 20 | 8.97496 | 55 | 11.02504 | 8.97691 | 55 | 11.02309 | 10.00194 | 1 | 9.99806 | 35 |
| 26 | 16 32 | 43 28 | 97629 | 57 | 02371 | 97825 | 58 | 02175 | 00196 | 1 | 99804 | 34 |
| 27 | 16 24 | 43 36 | 97762 | 59 | 02238 | 97959 | 60 | 02041 | 00197 | 1 | 99803 | 33 |
| 28 | 16 16 | 43 44 | 97894 | 61 | 02106 | 98092 | 62 | 01908 | 00198 | 1 | 99802 | 32 |
| 29 | 16 08 | 43 52 | 98026 | 64 | 01974 | 98225 | 64 | 01775 | 00199 | 1 | 99801 | 31 |
| 30 | 11 16 00 | 0 44 00 | 8.98157 | 66 | 11.01843 | 8.98358 | 66 | 11.01642 | 10.00200 | 1 | 9.99800 | 30 |
| 31 | 15 52 | 44 08 | 98288 | 68 | 01712 | 98490 | 69 | 01510 | 00202 | 1 | 99798 | 29 |
| 32 | 15 44 | 44 16 | 98419 | 70 | 01581 | 98622 | 71 | 01378 | 00203 | 1 | 99797 | 28 |
| 33 | 15 36 | 44 24 | 98549 | 72 | 01451 | 98753 | 73 | 01247 | 00204 | 1 | 99796 | 27 |
| 34 | 15 28 | 44 32 | 98679 | 75 | 01321 | 98884 | 75 | 01116 | 00205 | 1 | 99795 | 26 |
| 35 | 11 15 20 | 0 44 40 | 8.98808 | 77 | 11.01192 | 8.99015 | 77 | 11.00985 | 10.00207 | 1 | 9.99793 | 25 |
| 36 | 15 12 | 44 48 | 98937 | 79 | 01063 | 99145 | 80 | 00855 | 00208 | 1 | 99792 | 24 |
| 37 | 15 04 | 44 56 | 99066 | 81 | 00934 | 99275 | 82 | 00725 | 00209 | 1 | 99791 | 23 |
| 38 | 14 56 | 45 04 | 99194 | 83 | 00806 | 99405 | 84 | 00595 | 00210 | 1 | 99790 | 22 |
| 39 | 14 48 | 45 12 | 99322 | 86 | 00678 | 99534 | 86 | 00466 | 00212 | 1 | 99788 | 21 |
| 40 | 11 14 40 | 0 45 20 | 8.99450 | 88 | 11.00550 | 8.99662 | 89 | 11.00338 | 10.00213 | 1 | 9.99787 | 20 |
| 41 | 14 32 | 45 28 | 99577 | 90 | 00423 | 99791 | 91 | 00209 | 00214 | 1 | 99786 | 19 |
| 42 | 14 24 | 45 36 | 99704 | 92 | 00296 | 99919 | 93 | 00081 | 00215 | 1 | 99785 | 18 |
| 43 | 14 16 | 45 44 | 99830 | 94 | 00170 | 9.00046 | 95 | 10.99954 | 00217 | 1 | 99783 | 17 |
| 44 | 14 08 | 45 52 | 99956 | 96 | 00044 | 00174 | 97 | 99826 | 00218 | 1 | 99782 | 16 |
| 45 | 11 14 00 | 0 46 00 | 9.00082 | 99 | 10.99918 | 9.00301 | 100 | 10.99699 | 10.00219 | 1 | 9.99781 | 15 |
| 46 | 13 52 | 46 08 | 00207 | 101 | 99793 | 00427 | 102 | 99573 | 00220 | 1 | 99780 | 14 |
| 47 | 13 44 | 46 16 | 00332 | 103 | 99668 | 00553 | 104 | 99447 | 00222 | 1 | 99778 | 13 |
| 48 | 13 36 | 46 24 | 00456 | 105 | 99544 | 00679 | 106 | 99321 | 00223 | 1 | 99777 | 12 |
| 49 | 13 28 | 46 32 | 00581 | 107 | 99419 | 00805 | 108 | 99195 | 00224 | 1 | 99776 | 11 |
| 50 | 11 13 20 | 0 46 40 | 9.00704 | 110 | 10.99296 | 9.00930 | 111 | 10.99070 | 10.00225 | 1 | 9.99775 | 10 |
| 51 | 13 12 | 46 48 | 00828 | 112 | 99172 | 01055 | 113 | 98945 | 00227 | 1 | 99773 | 9 |
| 52 | 13 04 | 46 56 | 00951 | 114 | 99049 | 01179 | 115 | 98821 | 00228 | 1 | 99772 | 8 |
| 53 | 12 56 | 47 04 | 01074 | 116 | 98926 | 01303 | 117 | 98697 | 00229 | 1 | 99771 | 7 |
| 54 | 12 48 | 47 12 | 01196 | 118 | 98804 | 01427 | 120 | 98573 | 00231 | 1 | 99769 | 6 |
| 55 | 11 12 40 | 0 47 20 | 9.01318 | 121 | 10.98682 | 9.01550 | 122 | 10.98450 | 10.00232 | 1 | 9.99768 | 5 |
| 56 | 12 32 | 47 28 | 01440 | 123 | 98560 | 01673 | 124 | 98327 | 00233 | 1 | 99767 | 4 |
| 57 | 12 24 | 47 36 | 01561 | 125 | 98439 | 01796 | 126 | 98204 | 00235 | 1 | 99765 | 3 |
| 58 | 12 16 | 47 44 | 01682 | 127 | 98318 | 01918 | 128 | 98082 | 00236 | 1 | 99764 | 2 |
| 59 | 12 08 | 47 52 | 01803 | 129 | 98197 | 02040 | 131 | 97960 | 00237 | 1 | 99763 | 1 |
| 60 | 12 00 | 48 00 | 01923 | 132 | 98077 | 02162 | 133 | 97838 | 00239 | 1 | 99761 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |

95°     A     A     B     B     C     C     84°

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. A | 16 | 33 | 49 | 66 | 82 | 99 | 115 |
| B | 17 | 33 | 50 | 66 | 83 | 100 | 116 |
| C | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

## TABLE 44.

Log. Sines, Tangents, and Secants.

| 6° | | | A | | A | B | | B | C | | C | 173° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 11 12 00 | 0 48 00 | 9. 01923 | 0 | 10. 98077 | 9. 02162 | 0 | 10. 97838 | 10. 00239 | 0 | 9. 99761 | 60 |
| 1 | 11 52 | 48 08 | 02043 | 2 | 97957 | 02283 | 2 | 97717 | 00240 | 0 | 99760 | 59 |
| 2 | 11 44 | 48 16 | 02163 | 4 | 97837 | 02404 | 4 | 97596 | 00241 | 0 | 99759 | 58 |
| 3 | 11 36 | 48 24 | 02283 | 6 | 97717 | 02525 | 6 | 97475 | 00243 | 0 | 99757 | 57 |
| 4 | 11 28 | 48 32 | 02402 | 7 | 97598 | 02645 | 8 | 97355 | 00244 | 0 | 99756 | 56 |
| 5 | 11 11 20 | 0 48 40 | 9. 02520 | 9 | 10. 97480 | 9. 02766 | 9 | 10. 97234 | 10. 00245 | 0 | 9. 99755 | 55 |
| 6 | 11 12 | 48 48 | 02639 | 11 | 97361 | 02885 | 11 | 97115 | 00247 | 0 | 99753 | 54 |
| 7 | 11 04 | 48 56 | 02757 | 13 | 97243 | 03005 | 13 | 96995 | 00248 | 0 | 99752 | 53 |
| 8 | 10 56 | 49 04 | 02874 | 15 | 97126 | 03124 | 15 | 96876 | 00249 | 0 | 99751 | 52 |
| 9 | 10 48 | 49 12 | 02992 | 17 | 97008 | 03242 | 17 | 96758 | 00251 | 0 | 99749 | 51 |
| 10 | 11 10 40 | 0 49 20 | 9. 03109 | 19 | 10. 96891 | 9. 03361 | 19 | 10. 96639 | 10. 00252 | 0 | 9. 99748 | 50 |
| 11 | 10 32 | 49 28 | 03226 | 20 | 96774 | 03479 | 21 | 96521 | 00253 | 0 | 99747 | 49 |
| 12 | 10 24 | 49 36 | 03342 | 22 | 96658 | 03597 | 23 | 96403 | 00255 | 0 | 99745 | 48 |
| 13 | 10 16 | 49 44 | 03458 | 24 | 96542 | 03714 | 24 | 96286 | 00256 | 0 | 99744 | 47 |
| 14 | 10 08 | 49 52 | 03574 | 26 | 96426 | 03832 | 26 | 96168 | 00258 | 0 | 99742 | 46 |
| 15 | 11 10 00 | 0 50 00 | 9. 03690 | 28 | 10. 96310 | 9. 03948 | 28 | 10. 96052 | 10. 00259 | 0 | 9. 99741 | 45 |
| 16 | 9 52 | 50 08 | 03805 | 30 | 96195 | 04065 | 30 | 95935 | 00260 | 0 | 99740 | 44 |
| 17 | 9 44 | 50 16 | 03920 | 31 | 96080 | 04181 | 32 | 95819 | 00262 | 0 | 99738 | 43 |
| 18 | 9 36 | 50 24 | 04034 | 33 | 95966 | 04297 | 34 | 95703 | 00263 | 0 | 99737 | 42 |
| 19 | 9 28 | 50 32 | 04149 | 35 | 95851 | 04413 | 36 | 95587 | 00264 | 0 | 99736 | 41 |
| 20 | 11 9 20 | 0 50 40 | 9. 04262 | 37 | 10. 95738 | 9. 04528 | 38 | 10. 95472 | 10. 00266 | 0 | 9. 99734 | 40 |
| 21 | 9 12 | 50 48 | 04376 | 39 | 95624 | 04643 | 39 | 95357 | 00267 | 1 | 99733 | 39 |
| 22 | 9 04 | 50 56 | 04490 | 41 | 95510 | 04758 | 41 | 95242 | 00269 | 1 | 99731 | 38 |
| 23 | 8 56 | 51 04 | 04603 | 43 | 95397 | 04873 | 43 | 95127 | 00270 | 1 | 99730 | 37 |
| 24 | 8 48 | 51 12 | 04715 | 44 | 95285 | 04987 | 45 | 95013 | 00272 | 1 | 99728 | 36 |
| 25 | 11 8 40 | 0 51 20 | 9. 04828 | 46 | 10. 95172 | 9. 05101 | 47 | 10. 94899 | 10. 00273 | 1 | 9. 99727 | 35 |
| 26 | 8 32 | 51 28 | 04940 | 48 | 95060 | 05214 | 49 | 94786 | 00274 | 1 | 99726 | 34 |
| 27 | 8 24 | 51 36 | 05052 | 50 | 94948 | 05328 | 51 | 94672 | 00276 | 1 | 99724 | 33 |
| 28 | 8 16 | 51 44 | 05164 | 52 | 94836 | 05441 | 53 | 94559 | 00277 | 1 | 99723 | 32 |
| 29 | 8 08 | 51 52 | 05275 | 54 | 94725 | 05553 | 54 | 94447 | 00279 | 1 | 99721 | 31 |
| 30 | 11 8 00 | 0 52 00 | 9. 05386 | 56 | 10. 94614 | 9. 05666 | 56 | 10. 94334 | 10. 00280 | 1 | 9. 99720 | 30 |
| 31 | 7 52 | 52 08 | 05497 | 57 | 94503 | 05778 | 58 | 94222 | 00282 | 1 | 99718 | 29 |
| 32 | 7 44 | 52 16 | 05607 | 59 | 94393 | 05890 | 60 | 94110 | 00283 | 1 | 99717 | 28 |
| 33 | 7 36 | 52 24 | 05717 | 61 | 94283 | 06002 | 62 | 93998 | 00284 | 1 | 99716 | 27 |
| 34 | 7 28 | 52 32 | 05827 | 63 | 94173 | 06113 | 64 | 93887 | 00286 | 1 | 99714 | 26 |
| 35 | 11 7 20 | 0 52 40 | 9. 05937 | 65 | 10. 94063 | 9. 06224 | 66 | 10. 93776 | 10. 00287 | 1 | 9. 99713 | 25 |
| 36 | 7 12 | 52 48 | 06046 | 67 | 93954 | 06335 | 68 | 93665 | 00289 | 1 | 99711 | 24 |
| 37 | 7 04 | 52 56 | 06155 | 69 | 93845 | 06445 | 69 | 93555 | 00290 | 1 | 99710 | 23 |
| 38 | 6 56 | 53 04 | 06264 | 70 | 93736 | 06556 | 71 | 93444 | 00292 | 1 | 99708 | 22 |
| 39 | 6 48 | 53 12 | 06372 | 72 | 93628 | 06666 | 73 | 93334 | 00293 | 1 | 99707 | 21 |
| 40 | 11 6 40 | 0 53 20 | 9. 06481 | 74 | 10. 93519 | 9. 06775 | 75 | 10. 93225 | 10. 00295 | 1 | 9. 99705 | 20 |
| 41 | 6 32 | 53 28 | 06589 | 76 | 93411 | 06885 | 77 | 93115 | 00296 | 1 | 99704 | 19 |
| 42 | 6 24 | 53 36 | 06696 | 78 | 93304 | 06994 | 79 | 93006 | 00298 | 1 | 99702 | 18 |
| 43 | 6 16 | 53 44 | 06804 | 80 | 93196 | 07103 | 81 | 92897 | 00299 | 1 | 99701 | 17 |
| 44 | 6 08 | 53 52 | 06911 | 81 | 93089 | 07211 | 83 | 92789 | 00301 | 1 | 99699 | 16 |
| 45 | 11 6 00 | 0 54 00 | 9. 07018 | 83 | 10. 92982 | 9. 07320 | 84 | 10. 92680 | 10. 00302 | 1 | 9. 99698 | 15 |
| 46 | 5 52 | 54 08 | 07124 | 85 | 92876 | 07428 | 86 | 92572 | 00304 | 1 | 99696 | 14 |
| 47 | 5 44 | 54 16 | 07231 | 87 | 92769 | 07536 | 88 | 92464 | 00305 | 1 | 99695 | 13 |
| 48 | 5 36 | 54 24 | 07337 | 89 | 92663 | 07643 | 90 | 92357 | 00307 | 1 | 99693 | 12 |
| 49 | 5 28 | 54 32 | 07442 | 91 | 92558 | 07751 | 92 | 92249 | 00308 | 1 | 99692 | 11 |
| 50 | 11 5 20 | 0 54 40 | 9. 07548 | 93 | 10. 92452 | 9. 07858 | 94 | 10. 92142 | 10. 00310 | 1 | 9. 99690 | 10 |
| 51 | 5 12 | 54 48 | 07653 | 94 | 92347 | 07964 | 96 | 92036 | 00311 | 1 | 99689 | 9 |
| 52 | 5 04 | 54 56 | 07758 | 96 | 92242 | 08071 | 98 | 91929 | 00313 | 1 | 99687 | 8 |
| 53 | 4 56 | 55 04 | 07863 | 98 | 92137 | 08177 | 99 | 91823 | 00314 | 1 | 99686 | 7 |
| 54 | 4 48 | 55 12 | 07968 | 100 | 92032 | 08283 | 101 | 91717 | 00316 | 1 | 99684 | 6 |
| 55 | 11 4 40 | 0 55 20 | 9. 08072 | 102 | 10. 91928 | 9. 08389 | 103 | 10. 91611 | 10. 00317 | 1 | 9. 99683 | 5 |
| 56 | 4 32 | 55 28 | 08176 | 104 | 91824 | 08495 | 105 | 91505 | 00319 | 1 | 99681 | 4 |
| 57 | 4 24 | 55 36 | 08280 | 106 | 91720 | 08600 | 107 | 91400 | 00320 | 1 | 99680 | 3 |
| 58 | 4 16 | 55 44 | 08383 | 107 | 91617 | 08705 | 109 | 91295 | 00322 | 1 | 99678 | 2 |
| 59 | 4 08 | 55 52 | 08486 | 109 | 91514 | 08810 | 111 | 91190 | 00323 | 1 | 99677 | 1 |
| 60 | 4 00 | 56 00 | 08589 | 111 | 91411 | 08914 | 113 | 91086 | 00325 | 1 | 99675 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 96° | | | A | | A | B | | B | C | | C | 83° |

| Seconds of time ....... | | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|---|
| Prop. parts of cols. | A | 14 | 28 | 42 | 56 | 69 | 83 | 97 |
| | B | 14 | 28 | 42 | 56 | 70 | 84 | 98 |
| | C | 0 | 0 | 1 | 1 | 1 | 1 | 1 |

## TABLE 44. [Page 615

### Log. Sines, Tangents, and Secants.

| 7° | | | A | | A | B | | B | C | | C | 172° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 11 4 0 | 0 56 0 | 9. 08589 | 0 | 10. 91411 | 9. 08914 | 0 | 10. 91086 | 10. 00325 | 0 | 9. 99675 | 60 |
| 1 | 3 52 | 56 8 | 08692 | 2 | 91308 | 09019 | 2 | 90981 | 00326 | 0 | 99674 | 59 |
| 2 | 3 44 | 56 16 | 08795 | 3 | 91205 | 09123 | 3 | 90877 | 00328 | 0 | 99672 | 58 |
| 3 | 3 36 | 56 24 | 08897 | 5 | 91103 | 09227 | 5 | 90773 | 00330 | 0 | 99670 | 57 |
| 4 | 3 28 | 56 32 | 08999 | 6 | 91001 | 09330 | 7 | 90670 | 00331 | 0 | 99669 | 56 |
| 5 | 11 3 20 | 0 56 40 | 9. 09101 | 8 | 10. 90899 | 9. 09434 | 8 | 10. 90566 | 10. 00333 | 0 | 9. 99667 | 55 |
| 6 | 3 12 | 56 48 | 09202 | 10 | 90798 | 09537 | 10 | 90463 | .00334 | 0 | 99666 | 54 |
| 7 | 3 4 | 56 56 | 09304 | 11 | 90696 | 09640 | 11 | 90360 | 00336 | 0 | 99664 | 53 |
| 8 | 2 56 | 57 4 | 09405 | 13 | 90595 | 09742 | 13. | 90258 | 00337 | 0 | 99663 | 52 |
| 9 | 2 48 | 57 12 | 09506 | 14 | 90494 | 09845 | 15 | 90155 | 00339 | 0 | 99661 | 51 |
| 10 | 11 2 40 | 0 57 20 | 9. 09606 | 16 | 10. 90394 | 9. 09947 | 16 | 10. 90053 | 10. 00341 | 0 | 9. 99659 | 50 |
| 11 | 2 32 | 57 28 | 09707 | 18 | 90293 | 10049 | 18 | 89951 | 00342 | 0 | 99658 | 49 |
| 12 | 2 24 | 57 36 | 09807 | 19 | 90193 | 10150 | 20 | 89850 | 00344 | 0 | 99656 | 48 |
| 13 | 2 16 | 57 44 | 09907 | 21 | 90093 | 10252 | 21· | 89748 | 00345 | 0 | 99655 | 47 |
| 14 | 2 8 | 57 52 | 10006 | 22 | 89994 | 10353 | 23 | 89647 | 00347 | 0 | 99653 | 46 |
| 15 | 11 2 0 | 0 58 0 | 9. 10106 | 24 | 10. 89894 | 9. 10454 | 24 | 10. 89546 | 10. 00349 | 0 | 9. 99651 | 45 |
| 16 | 1 52 | 58 8 | 10205 | 26 | 89795 | 10555 | 26 | 89445 | 00350 | 0 | 99650 | 44 |
| 17 | 1 44 | 58 16 | 10304 | 27 | 89696 | 10656 | 28 | 89344 | 00352 | 0 | 99648 | 43 |
| 18 | 1 36 | 58 24 | 10402 | 29 | 89598 | 10756 | 29 | 89244 | 00353 | 1 | 99647 | 42 |
| 19 | 1 28 | 58 32 | 10501 | 30 | 89499 | 10856 | 31 | 89144 | 00355 | 1 | 99645 | 41 |
| 20 | 11 1 20 | 0 58 40 | 9. 10599 | 32 | 10. 89401 | 9. 10956 | 33 | 10. 89044 | 10. 00357 | 1 | 9. 99643 | 40 |
| 21 | 1 12 | 58 48 | 10697 | 34 | 89303 | 11056 | 34 | 88944 | 00358 | 1 | 99642 | 39 |
| 22 | 1 4 | 58 56 | 10795 | 35 | 89205 | 11155 | 36 | 88845 | 00360 | 1 | 99640 | 38 |
| 23 | 0 56 | 59 4 | 10893 | 37 | 89107 | 11254 | 37 | 88746 | 00362 | 1 | 99638 | 37 |
| 24 | 0 48 | 59 12 | 10990 | 38 | 89010 | 11353 | 39 | 88647 | 00363 | 1 | 99637 | 36 |
| 25 | 11 0 40 | 0 59 20 | 9. 11087 | 40 | 10. 88913 | 9. 11452 | 41 | 10. 88548 | 10. 00365 | 1 | 9. 99635 | 35 |
| 26 | 0 32 | 59 28 | 11184 | 42 | 88816 | 11551 | 42 | 88449 | 00367 | 1 | 99633 | 34 |
| 27 | 0 24 | 59 36 | 11281 | 43 | 88719 | 11649 | 44 | 88351 | 00368 | 1 | 99632 | 33 |
| 28 | 0 16 | 59 44 | 11377 | 45 | 88623 | 11747 | 46 | 88253 | 00370 | 1 | 99630 | 32 |
| 29 | 0 8 | 59 52 | 11474 | 46 | 88526 | 11845 | 47 | 88155 | 00371 | 1 | 99629 | 31 |
| 30 | 11 0 0 | 1 0 0 | 9. 11570 | 48 | 10. 88430 | 9. 11943 | 49 | 10. 88057 | 10. 00373 | 1 | 9. 99627 | 30 |
| 31 | 10 59 52 | 0 8 | 11666 | 50 | 88334 | 12040 | 51 | 87960 | 00375 | 1. | 99625 | 29 |
| 32 | 59 44 | 0 16 | 11761 | 51 | 88239 | 12138 | 52 | 87862 | 00376 | 1 | 99624 | 28 |
| 33 | 59 36 | 0 24 | 11857 | 53 | 88143 | 12235 | 54 | 87765 | 00378 | 1 | 99622 | 27 |
| 34 | 59 28 | 0 32 | 11952 | 54 | 88048 | 12332 | 55 | 87668 | 00380 | 1 | 99620 | 26 |
| 35 | 10 59 20 | 1 0 40 | 9. 12047 | 56 | 10. 87953 | 9. 12428 | 57 | 10. 87572 | 10. 00382 | 1 | 9. 99618 | 25 |
| 36 | 59 12 | 0 48 | 12142 | 58 | 87858 | 12525 | 59 | 87475 | 00383 | 1 | 99617 | 24 |
| 37 | 59 4 | 0 56 | 12236 | 59 | 87764 | 12621 | 60 | ·87379 | 00385 | 1 | 99615 | 23 |
| 38 | 58 56 | 1 4 | 12331 | 61 | 87669 | 12717 | 62 | 87283 | 00387 | 1 | 99613 | 22 |
| 39 | 58 48 | 1 12 | 12425 | 62 | 87575 | 12813 | 64 | 87187 | 00388 | 1 | 99612 | 21 |
| 40 | 10 58 40 | 1 1 20 | 9. 12519 | 64 | 10. 87481 | 9. 12909 | 65 | 10. 87091 | 10. 00390 | 1 | 9. 99610 | 20 |
| 41 | 58 32 | 1 28 | 12612 | 66 | 87388 | 13004 | 67 | 86996 | 00392 | ·1 | 99608 | 19 |
| 42 | 58 24 | 1 36 | 12706 | 67 | 87294 | 13099 | 68 | 86901 | 00393 | 1 | 99607 | 18 |
| 43 | 58 16 | 1 44 | 12799 | 69 | 87201 | 13194 | 70 | 86806 | 00395 | 1 | 99605 | 17 |
| 44 | 58 8 | 1 52 | 12892 | 70 | 87108 | 13289 | 72 | 86711 | 00397 | 1 | 99603 | 16 |
| 45 | 10 58 0 | 1 2 0 | 9. 12985 | 72 | 10. 87015 | 9. 13384 | 73 | 10. 86616 | 10. 00399 | 1 | 9. 99601 | 15 |
| 46 | 57 52 | 2 8 | 13078 | 74 | 86922 | 13478 | 75 | 86522 | 00400 | 1 | 99600 | 14 |
| 47 | 57 44 | 2 16 | 13171 | 75 | 86829 | 13573 | 77 | 86427 | 00402 | 1 | 99598 | 13 |
| 48 | 57 36 | 2 24 | 13263 | 77 | 86737 | 13667 | 78 | 86333 | 00404 | 1 | 99596 | 12 |
| 49 | 57 28 | 2 32 | 13355 | 78 | 86645 | 13761 | 80 | 86239 | 00405 | 1 | 99595 | 11 |
| 50 | 10 57 20 | 1 2 40 | 9. 13447 | 80 | 10. 86553 | 9. 13854 | 81 | 10. 86146 | 10. 00407 | 1 | 9. 99593 | 10 |
| 51 | 57 12 | 2 48 | 13539 | 82 | 86461 | 13948 | 83 | 86052 | 00409 | 1 | 99591 | 9 |
| 52 | .57 4 | 2 56 | 13630 | 83 | 86370 | 14041 | 85 | 85959 | 00411 | 1 | 99589 | 8 |
| 53 | 56 56 | 3 4 | 13722 | 85 | 86278 | 14134 | 86 | 85866 | 00412 | 1 | 99588 | 7 |
| 54 | 56 48 | 3 12 | 13813 | ·87 | 86187 | 14227 | 88 | 85773 | 00414 | 2 | 99586 | 6 |
| 55 | 10 56 40 | 1 3 20 | 9. 13904 | 88 | 10. 86096 | 9. 14320 | 90 | 10. 85680 | 10. 00416 | 2 | 9. 99584 | 5 |
| 56 | 56 32 | 3 28 | 13994 | 90 | 86006 | 14412 | 91 | 85588 | 00418 | 2 | 99582 | 4 |
| 57 | 56 24 | 3 36 | 14085 | 91 | 85915 | 14504 | 93 | 85496 | 00419 | 2 | 99581 | 3 |
| 58 | 56 16 | 3 44 | 14175 | 93 | 85825 | 14597 | 95 | 85403 | 00421 | 2 | 99579 | 2 |
| 59 | 56 8 | 3 52 | 14266 | 95· | 85734 | 14688 | 96 | 85312 | 00423 | 2 | 99577 | 1 |
| 60 | 56 0 | 4 0 | 14356 | 96 | 85644 | 14780 | 98 | 85220 | 00425 | 2 | 99575 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 97° | | | A | | A | B | | B | C | | C | 82° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
| B | 12 | 24 | 37 | 49 | 61 | 73 | 86 |
| C | 0 | 0 | 1 | 1 | 1 | 1 | I |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

| 8° | | | A | | A | B | | B | C | | C | 171° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 10 56 0 | 1 4 0 | 9.14356 | 0 | 10.85644 | 9.14780 | 0 | 10.85220 | 10.00425 | 0 | 9.99575 | 60 |
| 1 | 55 52 | 4 8 | 14445 | 1 | 85555 | 14872 | 1 | 85128 | 00426 | 0 | 99574 | 59 |
| 2 | 55 44 | 4 16 | 14535 | 3 | 85465 | 14963 | 3 | 85037 | 00428 | 0 | 99572 | 58 |
| 3 | 55 36 | 4 24 | 14624 | 4 | 85376 | 15054 | 4 | 84946 | 00430 | 0 | 99570 | 57 |
| 4 | 55 28 | 4 32 | 14714 | 6 | 85286 | 15145 | 6 | 84855 | 00432 | 0 | 99568 | 56 |
| 5 | 10 55 20 | 1 4 40 | 9.14803 | 7 | 10.85197 | 9.15236 | 7 | 10.84764 | 10.00434 | 0 | 9.99566 | 55 |
| 6 | 55 12 | 4 48 | 14891 | 8 | 85109 | 15327 | 9 | 84673 | 00435 | 0 | 99565 | 54 |
| 7 | 55 4 | 4 56 | 14980 | 10 | 85020 | 15417 | 10 | 84583 | 00437 | 0 | 99563 | 53 |
| 8 | 54 56 | 5 4 | 15069 | 11 | 84931 | 15508 | 12 | 84492 | 00439 | 0 | 99561 | 52 |
| 9 | 54 48 | 5 12 | 15157 | 13 | 84843 | 15598 | 13 | 84402 | 00441 | 0 | 99559 | 51 |
| 10 | 10 54 40 | 1 5 20 | 9.15245 | 14 | 10.84755 | 9.15688 | 14 | 10.84312 | 10.00443 | 0 | 9.99557 | 50 |
| 11 | 54 32 | 5 28 | 15333 | 16 | 84667 | 15777 | 16 | 84223 | 00444 | 0 | 99556 | 49 |
| 12 | 54 24 | 5 36 | 15421 | 17 | 84579 | 15867 | 17 | 84133 | 00446 | 0 | 99554 | 48 |
| 13 | 54 16 | 5 44 | 15508 | 18 | 84492 | 15956 | 19 | 84044 | 00448 | 0 | 99552 | 47 |
| 14 | 54 8 | 5 52 | 15596 | 20 | 84404 | 16046 | 20 | 83954 | 00450 | 0 | 99550 | 46 |
| 15 | 10 54 0 | 1 6 0 | 9.15683 | 21 | 10.84317 | 9.16135 | 22 | 10.83865 | 10.00452 | 0 | 9.99548 | 45 |
| 16 | 53 52 | 6 8 | 15770 | 23 | 84230 | 16224 | 23 | 83776 | 00454 | 1 | 99546 | 44 |
| 17 | 53 44 | 6 16 | 15857 | 24 | 84143 | 16312 | 25 | 83688 | 00455 | 1 | 99545 | 43 |
| 18 | 53 36 | 6 24 | 15944 | 25 | 84056 | 16401 | 26 | 83599 | 00457 | 1 | 99543 | 42 |
| 19 | 53 28 | 6 32 | 16030 | 27 | 83970 | 16489 | 27 | 83511 | 00459 | 1 | 99541 | 41 |
| 20 | 10 53 20 | 1 6 40 | 9.16116 | 28 | 10.83884 | 9.16577 | 29 | 10.83423 | 10.00461 | 1 | 9.99539 | 40 |
| 21 | 53 12 | 6 48 | 16203 | 30 | 83797 | 16665 | 30 | 83335 | 00463 | 1 | 99537 | 39 |
| 22 | 53 4 | 6 56 | 16289 | 31 | 83711 | 16753 | 32 | 83247 | 00465 | 1 | 99535 | 38 |
| 23 | 52 56 | 7 4 | 16374 | 32 | 83626 | 16841 | 33 | 83159 | 00467 | 1 | 99533 | 37 |
| 24 | 52 48 | 7 12 | 16460 | 34 | 83540 | 16928 | 35 | 83072 | 00468 | 1 | 99532 | 36 |
| 25 | 10 52 40 | 1 7 20 | 9.16545 | 35 | 10.83455 | 9.17016 | 36 | 10.82984 | 10.00470 | 1 | 9.99530 | 35 |
| 26 | 52 32 | 7 28 | 16631 | 37 | 83369 | 17103 | 37 | 82897 | 00472 | 1 | 99528 | 34 |
| 27 | 52 24 | 7 36 | 16716 | 38 | 83284 | 17190 | 39 | 82810 | 00474 | 1 | 99526 | 33 |
| 28 | 52 16 | 7 44 | 16801 | 39 | 83199 | 17277 | 40 | 82723 | 00476 | 1 | 99524 | 32 |
| 29 | 52 8 | 7 52 | 16886 | 41 | 83114 | 17363 | 42 | 82637 | 00478 | 1 | 99522 | 31 |
| 30 | 10 52 0 | 1 8 0 | 9.16970 | 42 | 10.83030 | 9.17450 | 43 | 10.82550 | 10.00480 | 1 | 9.99520 | 30 |
| 31 | 51 52 | 8 8 | 17055 | 44 | 82945 | 17536 | 45 | 82464 | 00482 | 1 | 99518 | 29 |
| 32 | 51 44 | 8 16 | 17139 | 45 | 82861 | 17622 | 46 | 82378 | 00483 | 1 | 99517 | 28 |
| 33 | 51 36 | 8 24 | 17223 | 47 | 82777 | 17708 | 48 | 82292 | 00485 | 1 | 99515 | 27 |
| 34 | 51 28 | 8 32 | 17307 | 48 | 82693 | 17794 | 49 | 82206 | 00487 | 1 | 99513 | 26 |
| 35 | 10 51 20 | 1 8 40 | 9.17391 | 49 | 10.82609 | 9.17880 | 50 | 10.82120 | 10.00489 | 1 | 9.99511 | 25 |
| 36 | 51 12 | 8 48 | 17474 | 51 | 82526 | 17965 | 52 | 82035 | 00491 | 1 | 99509 | 24 |
| 37 | 51 4 | 8 56 | 17558 | 52 | 82442 | 18051 | 53 | 81949 | 00493 | 1 | 99507 | 23 |
| 38 | 50 56 | 9 4 | 17641 | 54 | 82359 | 18136 | 55 | 81864 | 00495 | 1 | 99505 | 22 |
| 39 | 50 48 | 9 12 | 17724 | 55 | 82276 | 18221 | 56 | 81779 | 00497 | 1 | 99503 | 21 |
| 40 | 10 50 40 | 1 9 20 | 9.17807 | 56 | 10.82193 | 9.18306 | 58 | 10.81694 | 10.00499 | 1 | 9.99501 | 20 |
| 41 | 50 32 | 9 28 | 17890 | 58 | 82110 | 18391 | 59 | 81609 | 00501 | 1 | 99499 | 19 |
| 42 | 50 24 | 9 36 | 17973 | 59 | 82027 | 18475 | 61 | 81525 | 00503 | 1 | 99497 | 18 |
| 43 | 50 16 | 9 44 | 18055 | 61 | 81945 | 18560 | 62 | 81440 | 00505 | 1 | 99495 | 17 |
| 44 | 50 8 | 9 52 | 18137 | 62 | 81863 | 18644 | 63 | 81356 | 00506 | 1 | 99494 | 16 |
| 45 | 10 50 0 | 1 10 0 | 9.18220 | 63 | 10.81780 | 9.18728 | 65 | 10.81272 | 10.00508 | 1 | 9.99492 | 15 |
| 46 | 49 52 | 10 8 | 18302 | 65 | 81698 | 18812 | 66 | 81188 | 00510 | 1 | 99490 | 14 |
| 47 | 49 44 | 10 16 | 18383 | 66 | 81617 | 18896 | 68 | 81104 | 00512 | 1 | 99488 | 13 |
| 48 | 49 36 | 10 24 | 18465 | 68 | 81535 | 18979 | 69 | 81021 | 00514 | 2 | 99486 | 12 |
| 49 | 49 28 | 10 32 | 18547 | 69 | 81453 | 19063 | 71 | 80937 | 00516 | 2 | 99484 | 11 |
| 50 | 10 49 20 | 1 10 40 | 9.18628 | 71 | 10.81372 | 9.19146 | 72 | 10.80854 | 10.00518 | 2 | 9.99482 | 10 |
| 51 | 49 12 | 10 48 | 18709 | 72 | 81291 | 19229 | 74 | 80771 | 00520 | 2 | 99480 | 9 |
| 52 | 49 4 | 10 56 | 18790 | 73 | 81210 | 19312 | 75 | 80688 | 00522 | 2 | 99478 | 8 |
| 53 | 48 56 | 11 4 | 18871 | 75 | 81129 | 19395 | 76 | 80605 | 00524 | 2 | 99476 | 7 |
| 54 | 48 48 | 11 12 | 18952 | 76 | 81048 | 19478 | 78 | 80522 | 00526 | 2 | 99474 | 6 |
| 55 | 10 48 40 | 1 11 20 | 9.19033 | 78 | 10.80967 | 9.19561 | 79 | 10.80439 | 10.00528 | 2 | 9.99472 | 5 |
| 56 | 48 32 | 11 28 | 19113 | 79 | 80887 | 19643 | 81 | 80357 | 00530 | 2 | 99470 | 4 |
| 57 | 48 24 | 11 36 | 19193 | 80 | 80807 | 19725 | 82 | 80275 | 00532 | 2 | 99468 | 3 |
| 58 | 48 16 | 11 44 | 19273 | 82 | 80727 | 19807 | 84 | 80193 | 00534 | 2 | 99466 | 2 |
| 59 | 48 8 | 11 52 | 19353 | 83 | 80647 | 19889 | 85 | 80111 | 00536 | 2 | 99464 | 1 |
| 60 | 48 0 | 12 0 | 19433 | 85 | 80567 | 19971 | 87 | 80029 | 00538 | 2 | 99462 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 98° | | | A | | A | B | | B | C | | C | 81° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 11 | 21 | 32 | 42 | 53 | 63 | 74 |
| {B | 11 | 22 | 32 | 43 | 54 | 65 | 76 |
| {C | 0 | 0 | 1 | 1 | 1 | 1 | 2 |

TABLE 44. [Page 617

## Log. Sines, Tangents, and Secants.

| 9° | | | A | | A | B | | B | C | | C | 170° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 10 48 0 | 1 12 0 | 9.19433 | 0 | 10.80567 | 9.19971 | 0 | 10.80029 | 10.00538 | 0 | 9.99462 | 60 |
| 1 | 47 52 | 12 8 | 19513 | 1 | 80487 | 20053 | 1 | 79947 | 00540 | 0 | 99460 | 59 |
| 2 | 47 44 | 12 16 | 19592 | 3 | 80408 | 20134 | 3 | 79865 | 00542 | 0 | 99458 | 58 |
| 3 | 47 36 | 12 24 | 19672 | 4 | 80328 | 20216 | 4 | 79784 | 00544 | 0 | 99456 | 57 |
| 4 | 47 28 | 12 32 | 19751 | 5 | 80249 | 20297 | 5 | 79703 | 00546 | 0 | 99454 | 56 |
| 5 | 10 47 20 | 1 12 40 | 9.19830 | 6 | 10.80170 | 9.20378 | 6 | 10.79622 | 10.00548 | 0 | 9.99452 | 55 |
| 6 | 47 12 | 12 48 | 19909 | 8 | 80091 | 20459 | 8 | 79541 | 00550 | 0 | 99450 | 54 |
| 7 | 47 4 | 12 56 | 19988 | 9 | 80012 | 20540 | 9 | 79460 | 00552 | 0 | 99448 | 53 |
| 8 | 46 56 | 13 4 | 20067 | 10 | 79933 | 20621 | 10 | 79379 | 00554 | 0 | 99446 | 52 |
| 9 | 46 48 | 13 12 | 20145 | 11 | 79855 | 20701 | 12 | 79299 | 00556 | 0 | 99444 | 51 |
| 10 | 10 46 40 | 1 13 20 | 9.20223 | 13 | 10.79777 | 9.20782 | 13 | 10.79218 | 10.00558 | 0 | 9.99442 | 50 |
| 11 | 46 32 | 13 28 | 20302 | 14 | 79698 | 20862 | 14 | 79138 | 00560 | 0 | 99440 | 49 |
| 12 | 46 24 | 13 36 | 20380 | 15 | 79620 | 20942 | 16 | 79058 | 00562 | 0 | 99438 | 48 |
| 13 | 46 16 | 13 44 | 20458 | 16 | 79542 | 21022 | 17 | 78978 | 00564 | 0 | 99436 | 47 |
| 14 | 46 8 | 13 52 | 20535 | 18 | 79465 | 21102 | 18 | 78898 | 00566 | 0 | 99434 | 46 |
| 15 | 10 46 0 | 1 14 0 | 9.20613 | 19 | 10.79387 | 9.21182 | 19 | 10.78818 | 10.00568 | 1 | 9.99432 | 45 |
| 16 | 45 52 | 14 8 | 20691 | 20 | 79309 | 21261 | 21 | 78739 | 00571 | 1 | 99429 | 44 |
| 17 | 45 44 | 14 16 | 20768 | 21 | 79232 | 21341 | 22 | 78659 | 00573 | 1 | 99427 | 43 |
| 18 | 45 36 | 14 24 | 20845 | 23 | 79155 | 21420 | 23 | 78580 | 00575 | 1 | 99425 | 42 |
| 19 | 45 28 | 14 32 | 20922 | 24 | 79078 | 21499 | 25 | 78501 | 00577 | 1 | 99423 | 41 |
| 20 | 10 45 20 | 1 14 40 | 9.20999 | 25 | 10.79001 | 9.21578 | 26 | 10.78422 | 10.00579 | 1 | 9.99421 | 40 |
| 21 | 45 12 | 14 48 | 21076 | 26 | 78924 | 21657 | 27 | 78343 | 00581 | 1 | 99419 | 39 |
| 22 | 45 4 | 14 56 | 21153 | 28 | 78847 | 21736 | 28 | 78264 | 00583 | 1 | 99417 | 38 |
| 23 | 44 56 | 15 4 | 21229 | 29 | 78771 | 21814 | 30 | 78186 | 00585 | 1 | 99415 | 37 |
| 24 | 44 48 | 15 12 | 21306 | 30 | 78694 | 21893 | 31 | 78107 | 00587 | 1 | 99413 | 36 |
| 25 | 10 44 40 | 1 15 20 | 9.21382 | 31 | 10.78618 | 9.21971 | 32 | 10.78029 | 10.00589 | 1 | 9.99411 | 35 |
| 26 | 44 32 | 15 28 | 21458 | 33 | 78542 | 22049 | 34 | 77951 | 00591 | 1 | 99409 | 34 |
| 27 | 44 24 | 15 36 | 21534 | 34 | 78466 | 22127 | 35 | 77873 | 00593 | 1 | 99407 | 33 |
| 28 | 44 16 | 15 44 | 21610 | 35 | 78390 | 22205 | 36 | 77795 | 00596 | 1 | 99404 | 32 |
| 29 | 44 8 | 15 52 | 21685 | 37 | 78315 | 22283 | 38 | 77717 | 00598 | 1 | 99402 | 31 |
| 30 | 10 44 0 | 1 16 0 | 9.21761 | 38 | 10.78239 | 9.22361 | 39 | 10.77639 | 10.00600 | 1 | 9.99400 | 30 |
| 31 | 43 52 | 16 8 | 21836 | 39 | 78164 | 22438 | 40 | 77562 | 00602 | 1 | 99398 | 29 |
| 32 | 43 44 | 16 16 | 21912 | 40 | 78088 | 22516 | 41 | 77484 | 00604 | 1 | 99396 | 28 |
| 33 | 43 36 | 16 24 | 21987 | 42 | 78013 | 22593 | 43 | 77407 | 00606 | 1 | 99394 | 27 |
| 34 | 43 28 | 16 32 | 22062 | 43 | 77938 | 22670 | 44 | 77330 | 00608 | 1 | 99392 | 26 |
| 35 | 10 43 20 | 1 16 40 | 9.22137 | 44 | 10.77863 | 9.22747 | 45 | 10.77253 | 10.00610 | 1 | 9.99390 | 25 |
| 36 | 43 12 | 16 48 | 22211 | 45 | 77789 | 22824 | 47 | 77176 | 00612 | 1 | 99388 | 24 |
| 37 | 43 4 | 16 56 | 22286 | 47 | 77714 | 22901 | 48 | 77099 | 00615 | 1 | 99385 | 23 |
| 38 | 42 56 | 17 4 | 22361 | 48 | 77639 | 22977 | 49 | 77023 | 00617 | 1 | 99383 | 22 |
| 39 | 42 48 | 17 12 | 22435 | 49 | 77565 | 23054 | 50 | 76946 | 00619 | 1 | 99381 | 21 |
| 40 | 10 42 40 | 1 17 20 | 9.22509 | 50 | 10.77491 | 9.23130 | 52 | 10.76870 | 10.00621 | 1 | 9.99379 | 20 |
| 41 | 42 32 | 17 28 | 22583 | 52 | 77417 | 23206 | 53 | 76794 | 00623 | 1 | 99377 | 19 |
| 42 | 42 24 | 17 36 | 22657 | 53 | 77343 | 23283 | 54 | 76717 | 00625 | 1 | 99375 | 18 |
| 43 | 42 16 | 17 44 | 22731 | 54 | 77269 | 23359 | 56 | 76641 | 00628 | 2 | 99372 | 17 |
| 44 | 42 8 | 17 52 | 22805 | 55 | 77195 | 23435 | 57 | 76565 | 00630 | 2 | 99370 | 16 |
| 45 | 10 42 0 | 1 18 0 | 9.22878 | 57 | 10.77122 | 9.23510 | 58 | 10.76490 | 10.00632 | 2 | 9.99368 | 15 |
| 46 | 41 52 | 18 8 | 22952 | 58 | 77048 | 23586 | 60 | 76414 | 00634 | 2 | 99366 | 14 |
| 47 | 41 44 | 18 16 | 23025 | 59 | 76975 | 23661 | 61 | 76339 | 00636 | 2 | 99364 | 13 |
| 48 | 41 36 | 18 24 | 23098 | 60 | 76902 | 23737 | 62 | 76263 | 00638 | 2 | 99362 | 12 |
| 49 | 41 28 | 18 32 | 23171 | 62 | 76829 | 23812 | 63 | 76188 | 00641 | 2 | 99359 | 11 |
| 50 | 10 41 20 | 1 18 40 | 9.23244 | 63 | 10.76756 | 9.23887 | 65 | 10.76113 | 10.00643 | 2 | 9.99357 | 10 |
| 51 | 41 12 | 18 48 | 23317 | 64 | 76683 | 23962 | 66 | 76038 | 00645 | 2 | 99355 | 9 |
| 52 | 41 4 | 18 56 | 23390 | 65 | 76610 | 24037 | 67 | 75963 | 00647 | 2 | 99353 | 8 |
| 53 | 40 56 | 19 4 | 23462 | 67 | 76538 | 24112 | 69 | 75888 | 00649 | 2 | 99351 | 7 |
| 54 | 40 48 | 19 12 | 23535 | 68 | 76465 | 24186 | 70 | 75814 | 00652 | 2 | 99348 | 6 |
| 55 | 10 40 40 | 1 19 20 | 9.23607 | 69 | 10.76393 | 9.24261 | 71 | 10.75739 | 10.00654 | 2 | 9.99346 | 5 |
| 56 | 40 32 | 19 28 | 23679 | 71 | 76321 | 24335 | 73 | 75665 | 00656 | 2 | 99344 | 4 |
| 57 | 40 24 | 19 36 | 23752 | 72 | 76248 | 24410 | 74 | 75590 | 00658 | 2 | 99342 | 3 |
| 58 | 40 16 | 19 44 | 23823 | 73 | 76177 | 24484 | 75 | 75516 | 00660 | 2 | 99340 | 2 |
| 59 | 40 8 | 19 52 | 23895 | 74 | 76105 | 24558 | 76 | 75442 | 00663 | 2 | 99337 | 1 |
| 60 | 40 0 | 20 0 | 23967 | 76 | 76033 | 24632 | 78 | 75368 | 00665 | 2 | 99335 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 99° | | | A | | A | B, | | B | C | | C | 80° |

| Seconds of time....... | 1s | 2s | 3s | 4s | 5s | 6s | 7s |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 9 | 19 | 28 | 38 | 47 | 57 | 66 |
| B | 10 | 19 | 29 | 39 | 49 | 58 | 68 |
| C | 0 | 1 | 1 | 1 | 1 | 2 | 2 |

# TABLE 44.

Log. Sines, Tangents, and Secants.

| 10° | | | A | | A | B | | B | C | | C | 169° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 10 40 0 | 1 20 0 | 9.23967 | 0 | 10.76033 | 9.24632 | 0 | 10.75368 | 10.00665 | 0 | 9.99335 | 60 |
| 1 | 39 52 | 20 8 | 24039 | 1 | 75961 | 24706 | 1 | 75294 | 00667 | 0 | 99333 | 59 |
| 2 | 39 44 | 20 16 | 24110 | 2 | 75890 | 24779 | 2 | 75221 | 00669 | 0 | 99331 | 58 |
| 3 | 39 36 | 20 24 | 24181 | 3 | 75819 | 24853 | 4 | 75147 | 00672 | 0 | 99328 | 57 |
| 4 | 39 28 | 20 32 | 24253 | 5 | 75747 | 24926 | 5 | 75074 | 00674 | 0 | 99326 | 56 |
| 5 | 10 39 20 | 1 20 40 | 9.24324 | 6 | 10.75676 | 9.25000 | 6 | 10.75000 | 10.00676 | 0 | 9.99324 | 55 |
| 6 | 39 12 | 20 48 | 24395 | 7 | 75605 | 25073 | 7 | 74927 | 00678 | 0 | 99322 | 54 |
| 7 | 39 4 | 20 56 | 24466 | 8 | 75534 | 25146 | 8 | 74854 | 00681 | 0 | 99319 | 53 |
| 8 | 38 56 | 21 4 | 24536 | 9 | 75464 | 25219 | 9 | 74781 | 00683 | 0 | 99317 | 52 |
| 9 | 38 48 | 21 12 | 24607 | 10 | 75393 | 25292 | 11 | 74708 | 00685 | 0 | 99315 | 51 |
| 10 | 10 38 40 | 1 21 20 | 9.24677 | 11 | 10.75323 | 9.25365 | 12 | 10.74635 | 10.00687 | 0 | 9.99313 | 50 |
| 11 | 38 32 | 21 28 | 24748 | 13 | 75252 | 25437 | 13 | 74563 | 00690 | 0 | 99310 | 49 |
| 12 | 38 24 | 21 36 | 24818 | 14 | 75182 | 25510 | 14 | 74490 | 00692 | 0 | 99308 | 48 |
| 13 | 38 16 | 21 44 | 24888 | 15 | 75112 | 25582 | 15 | 74418 | 00694 | 1 | 99306 | 47 |
| 14 | 38 8 | 21 52 | 24958 | 16 | 75042 | 25655 | 16 | 74345 | 00696 | 1 | 99304 | 46 |
| 15 | 10 38 0 | 1 22 0 | 9.25028 | 17 | 10.74972 | 9.25727 | 18 | 10.74273 | 10.00699 | 1 | 9.99301 | 45 |
| 16 | 37 52 | 22 8 | 25098 | 18 | 74902 | 25799 | 19 | 74201 | 00701 | 1 | 99299 | 44 |
| 17 | 37 44 | 22 16 | 25168 | 19 | 74832 | 25871 | 20 | 74129 | 00703 | 1 | 99297 | 43 |
| 18 | 37 36 | 22 24 | 25237 | 20 | 74763 | 25943 | 21 | 74057 | 00706 | 1 | 99294 | 42 |
| 19 | 37 28 | 22 32 | 25307 | 22 | 74693 | 26015 | 22 | 73985 | 00708 | 1 | 99292 | 41 |
| 20 | 10 37 20 | 1 22 40 | 9.25376 | 23 | 10.74624 | 9.26086 | 24 | 10.73914 | 10.00710 | 1 | 9.99290 | 40 |
| 21 | 37 12 | 22 48 | 25445 | 24 | 74555 | 26158 | 25 | 73842 | 00712 | 1 | 99288 | 39 |
| 22 | 37 4 | 22 56 | 25514 | 25 | 74486 | 26229 | 26 | 73771 | 00715 | 1 | 99285 | 38 |
| 23 | 36 56 | 23 4 | 25583 | 26 | 74417 | 26301 | 27 | 73699 | 00717 | 1 | 99283 | 37 |
| 24 | 36 48 | 23 12 | 25652 | 27 | 74348 | 26372 | 28 | 73628 | 00719 | 1 | 99281 | 36 |
| 25 | 10 36 40 | 1 23 20 | 9.25721 | 28 | 10.74279 | 9.26443 | 29 | 10.73557 | 10.00722 | 1 | 9.99278 | 35 |
| 26 | 36 32 | 23 28 | 25790 | 29 | 74210 | 26514 | 31 | 73486 | 00724 | 1 | 99276 | 34 |
| 27 | 36 24 | 23 36 | 25858 | 31 | 74142 | 26585 | 32 | 73415 | 00726 | 1 | 99274 | 33 |
| 28 | 36 16 | 23 44 | 25927 | 32 | 74073 | 26655 | 33 | 73345 | 00729 | 1 | 99271 | 32 |
| 29 | 36 8 | 23 52 | 25995 | 33 | 74005 | 26726 | 34 | 73274 | 00731 | 1 | 99269 | 31 |
| 30 | 10 36 0 | 1 24 0 | 9.26063 | 34 | 10.73937 | 9.26797 | 35 | 10.73203 | 10.00733 | 1 | 9.99267 | 30 |
| 31 | 35 52 | 24 8 | 26131 | 35 | 73869 | 26867 | 36 | 73133 | 00736 | 1 | 99264 | 29 |
| 32 | 35 44 | 24 16 | 26199 | 36 | 73801 | 26937 | 38 | 73063 | 00738 | 1 | 99262 | 28 |
| 33 | 35 36 | 24 24 | 26267 | 38 | 73733 | 27008 | 39 | 72992 | 00740 | 1 | 99260 | 27 |
| 34 | 35 28 | 24 32 | 26335 | 39 | 73665 | 27078 | 40 | 72922 | 00743 | 1 | 99257 | 26 |
| 35 | 10 35 20 | 1 24 40 | 9.26403 | 40 | 10.73597 | 9.27148 | 41 | 10.72852 | 10.00745 | 1 | 9.99255 | 25 |
| 36 | 35 12 | 24 48 | 26470 | 41 | 73530 | 27218 | 42 | 72782 | 00748 | 1 | 99252 | 24 |
| 37 | 35 4 | 24 56 | 26538 | 42 | 73462 | 27288 | 44 | 72712 | 00750 | 1 | 99250 | 23 |
| 38 | 34 56 | 25 4 | 26605 | 43 | 73395 | 27357 | 45 | 72643 | 00752 | 1 | 99248 | 22 |
| 39 | 34 48 | 25 12 | 26672 | 44 | 73328 | 27427 | 46 | 72573 | 00755 | 2 | 99245 | 21 |
| 40 | 10 34 40 | 1 25 20 | 9.26739 | 45 | 10.73261 | 9.27496 | 47 | 10.72504 | 10.00757 | 2 | 9.99243 | 20 |
| 41 | 34 32 | 25 28 | 26806 | 47 | 73194 | 27566 | 48 | 72434 | 00759 | 2 | 99241 | 19 |
| 42 | 34 24 | 25 36 | 26873 | 48 | 73127 | 27635 | 49 | 72365 | 00762 | 2 | 99238 | 18 |
| 43 | 34 16 | 25 44 | 26940 | 49 | 73060 | 27704 | 51 | 72296 | 00764 | 2 | 99236 | 17 |
| 44 | 34 8 | 25 52 | 27007 | 50 | 72993 | 27773 | 52 | 72227 | 00767 | 2 | 99233 | 16 |
| 45 | 10 34 0 | 1 26 0 | 9.27073 | 51 | 10.72927 | 9.27842 | 53 | 10.72158 | 10.00769 | 2 | 9.99231 | 15 |
| 46 | 33 52 | 26 8 | 27140 | 52 | 72860 | 27911 | 54 | 72089 | 00771 | 2 | 99229 | 14 |
| 47 | 33 44 | 26 16 | 27206 | 53 | 72794 | 27980 | 55 | 72020 | 00774 | 2 | 99226 | 13 |
| 48 | 33 36 | 26 24 | 27273 | 55 | 72727 | 28049 | 56 | 71951 | 00776 | 2 | 99224 | 12 |
| 49 | 33 28 | 26 32 | 27339 | 56 | 72661 | 28117 | 58 | 71883 | 00779 | 2 | 99221 | 11 |
| 50 | 10 33 20 | 1 26 40 | 9.27405 | 57 | 10.72595 | 9.28186 | 59 | 10.71814 | 10.00781 | 2 | 9.99219 | 10 |
| 51 | 33 12 | 26 48 | 27471 | 58 | 72529 | 28254 | 60 | 71746 | 00783 | 2 | 99217 | 9 |
| 52 | 33 4 | 26 56 | 27537 | 59 | 72463 | 28323 | 61 | 71677 | 00786 | 2 | 99214 | 8 |
| 53 | 32 56 | 27 4 | 27602 | 60 | 72398 | 28391 | 62 | 71609 | 00788 | 2 | 99212 | 7 |
| 54 | 32 48 | 27 12 | 27668 | 61 | 72332 | 28459 | 63 | 71541 | 00791 | 2 | 99209 | 6 |
| 55 | 10 32 40 | 1 27 20 | 9.27734 | 63 | 10.72266 | 9.28527 | 65 | 10.71473 | 10.00793 | 2 | 9.99207 | 5 |
| 56 | 32 32 | 27 28 | 27799 | 64 | 72201 | 28595 | 66 | 71405 | 00796 | 2 | 99204 | 4 |
| 57 | 32 24 | 27 36 | 27864 | 65 | 72136 | 28662 | 67 | 71338 | 00798 | 2 | 99202 | 3 |
| 58 | 32 16 | 27 44 | 27930 | 66 | 72070 | 28730 | 68 | 71270 | 00800 | 2 | 99200 | 2 |
| 59 | 32 8 | 27 52 | 27995 | 67 | 72005 | 28798 | 69 | 71202 | 00803 | 2 | 99197 | 1 |
| 60 | 32 0 | 28 0 | 28060 | 68 | 71940 | 28865 | 71 | 71135 | 00805 | 2 | 99195 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 100° | | | A | | A | B | | B | C | | C | 79° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 9 | 17 | 26 | 34 | 43 | 51 | 60 |
| B | 9 | 18 | 26 | 35 | 44 | 53 | 62 |
| C | 0 | 1 | 1 | 1 | 1 | 2 | 2 |

TABLE 44.                     [Page 619

Log. Sines, Tangents, and Secants.

11°                                    A            A         B                    B           C              C        168°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 10 32 0 | 1 28 0 | 9. 28060 | 0 | 10. 71940 | 9. 28865 | 0 | 10. 71135 | 10. 00805 | 0 | 9. 99195 | 60 |
| 1 | 31 52 | 28 8 | 28125 | 1 | 71875 | 28933 | 1 | 71067 | 00808 | 0 | 99192 | 59 |
| 2 | 31 44 | 28 16 | 28190 | 2 | 71810 | 29000 | 2 | 71000 | 00810 | 0 | 99190 | 58 |
| 3 | 31 36 | 28 24 | 28254 | 3 | 71746 | 29067 | 3 | 70933 | 00813 | 0 | 99187 | 57 |
| 4 | 31 28 | 28 32 | 28319 | 4 | 71681 | 29134 | 4 | 70866 | 00815 | 0 | 99185 | 56 |
| 5 | 10 31 20 | 1 28 40 | 9. 28384 | 5 | 10. 71616 | 9. 29201 | 5 | 10. 70799 | 10. 00818 | 0 | 9. 99182 | 55 |
| 6 | 31 12 | 28 48 | 28448 | 6 | 71552 | 29268 | 6 | 70732 | 00820 | 0 | 99180 | 54 |
| 7 | 31 4 | 28 56 | 28512 | 7 | 71488 | 29335 | 8 | 70665 | 00823 | 0 | 99177 | 53 |
| 8 | 30 56 | 29 4 | 28577 | 8 | 71423 | 29402 | 9 | 70598 | 00825 | 0 | 99175 | 52 |
| 9 | 30 48 | 29 12 | 28641 | 9 | 71359 | 29468 | 10 | 70532 | 00828 | 0 | 99172 | 51 |
| 10 | 10 30 40 | 1 29 20 | 9. 28705 | 10 | 10. 71295 | 9. 29535 | 11 | 10. 70465 | 10. 00830 | 0 | 9. 99170 | 50 |
| 11 | 30 32 | 29 28 | 28769 | 11 | 71231 | 29601 | 12 | 70399 | 00833 | 0 | 99167 | 49 |
| 12 | 30 24 | 29 36 | 28833 | 12 | 71167 | 29668 | 13 | 70332 | 00835 | 1 | 99165 | 48 |
| 13 | 30 16 | 29 44 | 28896 | 13 | 71104 | 29734 | 14 | 70266 | 00838 | 1 | 99162 | 47 |
| 14 | 30 8 | 29 52 | 28960 | 14 | 71040 | 29800 | 15 | 70200 | 00840 | 1 | 99160 | 46 |
| 15 | 10 30 0 | 1 30 0 | 9. 29024 | 16 | 10. 70976 | 9. 29866 | 16 | 10. 70134 | 10. 00843 | 1 | 9. 99157 | 45 |
| 16 | 29 52 | 30 8 | 29087 | 17 | 70913 | 29932 | 17 | 70068 | 00845 | 1 | 99155 | 44 |
| 17 | 29 44 | 30 16 | 29150 | 18 | 70850 | · 29998 | 18 | 70002 | 00848 | 1 | 99152 | 43 |
| 18 | 29 36 | 30 24 | 29214 | 19 | 70786 | 30064 | 19 | 69936 | 00850 | 1 | 99150 | 42 |
| 19 | 29 28 | 30 32 | 29277 | 20 | 70723 | 30130 | 20 | 69870 | 00853 | 1 | 99147 | 41 |
| 20 | 10 29 20 | 1 30 40 | 9. 29340 | 21 | 10. 70660 | 9. 30195 | 22 | 10. 69805 | 10. 00855 | 1 | 9. 99145 | 40 |
| 21 | 29 12 | 30 48 | 29403 | 22 | 70597 | 30261 | 23 | 69739 | 00858 | 1 | 99142 | 39 |
| 22 | 29 4 | 30 56 | 29466 | 23 | 70534 | 30326 | 24 | 69674 | 00860 | 1 | 99140 | 38 |
| 23 | 28 56 | 31 4 | 29529 | 24 | 70471 | 30391 | 25 | 69609 | 00863 | 1 | 99137 | 37 |
| 24 | 28 48 | 31 12 | 29591 | 25 | 70409 | 30457 | 26 | 69543 | 00865 | 1 | 99135 | 36 |
| 25 | 10 28 40 | 1 31 20 | 9. 29654 | 26 | 10. 70346 | 9. 30522 | 27 | 10. 69478 | 10. 00868 | 1 | 9. 99132 | 35 |
| 26 | 28 32 | 31 28 | 29716 | 27 | 70284 | 30587 | 28 | 69413 | 00870 | 1 | 99130 | 34 |
| 27 | 28 24 | 31 36 | 29779 | 28 | 70221 | 30652 | 29 | 69348 | 00873 | 1 | 99127 | 33 |
| 28 | 28 16 | 31 44 | 29841 | 29 | 70159 | 30717 | 30 | 69283 | 00876 | 1 | 99124 | 32 |
| 29 | 28 8 | 31 52 | 29903 | 30 | 70097 | 30782 | 31 | 69218 | 00878 | 1 | 99122 | 31 |
| 30 | 10 28 0 | 1 32 0 | 9. 29966 | 31 | 10. 70034 | 9. 30846 | 32 | 10. 69154 | 10. 00881 | 1 | 9. 99119 | 30 |
| 31 | 27 52 | 32 8 | 30028 | 32 | 69972 | 30911 | 33 | 69089 | 00883 | 1 | 99117 | 29 |
| 32 | 27 44 | 32 16 | 30090 | 33 | 69910 | 30975 | 35 | 69025 | 00886 | 1 | 99114 | 28 |
| 33 | 27 36 | 32 24 | 30151 | 34 | 69849 | 31040 | 36 | 68960 | 00888 | 1 | 99112 | 27 |
| 34 | 27 28 | 32 32 | 30213 | 35 | 69787 | 31104 | 37 | 68896 | 00891 | 1 | 99109 | 26 |
| 35 | 10 27 20 | 1 32 40 | 9. 30275 | 36 | 10. 69725 | 9. 31168 | 38 | 10. 68832 | 10. 00894 | 2 | 9. 99106 | 25 |
| 36 | 27 12 | 32 48 | 30336 | 37 | 69664 | 31233 | 39 | 68767 | 00896 | 2 | 99104 | 24 |
| 37 | 27 4 | 32 56 | 30398 | 38 | 69602 | 31297 | 40 | 68703 | 00899 | 2 | 99101 | 23 |
| 38 | 26 56 | 33 4 | 30459 | 39 | 69541 | 31361 | 41 | 68639 | 00901 | 2 | 99099 | 22 |
| 39 | 26 48 | 33 12 | 30521 | 40 | 69479 | 31425 | 42 | 68575 | 00904 | 2 | 99096 | 21 |
| 40 | 10 26 40 | 1 33 20 | 9. 30582 | 41 | 10. 69418 | 9. 31489 | 43 | 10. 68511 | 10. 00907 | 2 | 9. 99093 | 20 |
| 41 | 26 32 | 33 28 | 30643 | 42 | 69357 | 31552 | 44 | 68448 | 00909 | 2 | 99091 | 19 |
| 42 | 26 24 | 33 36 | 30704 | 43 | 69296 | 31616 | 45 | 68384 | 00912 | 2 | 99088 | 18 |
| 43 | 26 16 | 33 44 | 30765 | 45 | 69235 | 31679 | 46 | 68321 | 00914 | 2 | 99086 | 17 |
| 44 | 26 8 | 33 52 | 30826 | 46 | 69174 | 31743 | 47 | 68257 | 00917 | 2 | 99083 | 16 |
| 45 | 10 26 0 | 1 34 0 | 9. 30887 | 47 | 10. 69113 | 9. 31806 | 49 | 10. 68194 | 10. 00920 | 2 | 9. 99080 | 15 |
| 46 | 25 52 | 34 8 | 30947 | 48 | 69053 | 31870 | 50 | 68130 | 00922 | 2 | 99078 | 14 |
| 47 | 25 44 | 34 16 | 31008 | 49 | 68992 | 31933 | 51 | 68067 | 00925 | 2 | 99075 | 13 |
| 48 | 25 36 | 34 24 | 31068 | 50 | 68932 | 31996 | 52 | 68004 | 00928 | 2 | 99072 | 12 |
| 49 | 25 28 | 34 32 | 31129 | 51 | 68871 | 32059 | 53 | 67941 | 00930 | 2 | 99070 | 11 |
| 50 | 10 25 20 | 1 34 40 | 9. 31189 | 52 | 10. 68811 | 9. 32122 | 54 | 10. 67878 | 10. 00933 | 2 | 9. 99067 | 10 |
| 51 | 25 12 | 34 48 | 31250 | 53 | 68750 | 32185 | 55 | 67815 | 00936 | 2 | 99064 | 9 |
| 52 | 25 4 | 34 56 | 31310 | 54 | 68690 | 32248 | 56 | 67752 | 00938 | 2 | 99062 | 8 |
| 53 | 24 56 | 35 4 | 31370 | 55 | 68630 | 32311 | 57 | 67689 | 00941 | 2 | 99059 | 7 |
| 54 | 24 48 | 35 12 | 31430 | 56 | 68570 | 32373 | 58 | 67627 | 00944 | 2 | 99056 | 6 |
| 55 | 10 24 40 | 1 35 20 | 9. 31490 | 57 | 10. 68510 | 9. 32436 | 59 | 10. 67564 | 10. 00946 | 2 | 9. 99054 | 5 |
| 56 | 24 32 | 35 28 | 31549 | 58 | 68451 | 32498 | 60 | 67502 | 00949 | 2 | 99051 | 4 |
| 57 | 24 24 | 35 36 | 31609 | 59 | 68391 | 32561 | 61 | 67439 | 00952 | 2 | 99048 | 3 |
| 58 | 24 16 | 35 44 | 31669 | 60 | 68331 | 32623 | 63 | 67377 | 00954 | 2 | 99046 | 2 |
| 59 | 24 8 | 35 52 | 31728 | 61 | 68272 | 32685 | 64 | 67315 | 00957 | 3 | 99043 | 1 |
| 60 | 24 0 | 36 0 | 31788 | 62 | 68212 | 32747 | 65 | 67253 | 00960 | 3 | 99040 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

101°                                  A            A         B                    B           C              C        78°

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 8 | 16 | 23 | 31 | 39 | 47 | 54 |
| B | 8 | 16 | 24 | 32 | 40 | 49 | 57 |
| C | 0 | 1 | 1 | 1 | 2 | 2 | 2 |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

**12°**     A    A    B    B    C    C    **167°**

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 10 24 0 | 1 36 0 | 9.31788 | 0 | 10.68212 | 9.32747 | 0 | 10.67253 | 10.00960 | 0 | 9.99040 | 60 |
| 1 | 23 52 | 36 8 | 31847 | 1 | 68153 | 32810 | 1 | 67190 | 00962 | 0 | 99038 | 59 |
| 2 | 23 44 | 36 16 | 31907 | 2 | 68093 | 32872 | 2 | 67128 | 00965 | 0 | 99035 | 58 |
| 3 | 23 36 | 36 24 | 31966 | 3 | 68034 | 32933 | 3 | 67067 | 00968 | 0 | 99032 | 57 |
| 4 | 23 28 | 36 32 | 32025 | 4 | 67975 | 32995 | 4 | 67005 | 00970 | 0 | 99030 | 56 |
| 5 | 10 23 20 | 1 36 40 | 9.32084 | 5 | 10.67916 | 9.33057 | 5 | 10.66943 | 10.00973 | 0 | 9.99027 | 55 |
| 6 | 23 12 | 36 48 | 32143 | 6 | 67857 | 33119 | 6 | 66881 | 00976 | 0 | 99024 | 54 |
| 7 | 23 4 | 36 56 | 32202 | 7 | 67798 | 33180 | 7 | 66820 | 00978 | 0 | 99022 | 53 |
| 8 | 22 56 | 37 4 | 32261 | 8 | 67739 | 33242 | 8 | 66758 | 00981 | 0 | 99019 | 52 |
| 9 | 22 48 | 37 12 | 32319 | 9 | 67681 | 33303 | 9 | 66697 | 00984 | 0 | 99016 | 51 |
| 10 | 10 22 40 | 1 37 20 | 9.32378 | 10 | 10.67622 | 9.33365 | 10 | 10.66635 | 10.00987 | 0 | 9.99013 | 50 |
| 11 | 22 32 | 37 28 | 32437 | 10 | 67563 | 33426 | 11 | 66574 | 00989 | 1 | 99011 | 49 |
| 12 | 22 24 | 37 36 | 32495 | 11 | 67505 | 33487 | 12 | 66513 | 00992 | 1 | 99008 | 48 |
| 13 | 22 16 | 37 44 | 32553 | 12 | 67447 | 33548 | 13 | 66452 | 00995 | 1 | 99005 | 47 |
| 14 | 22 8 | 37 52 | 32612 | 13 | 67388 | 33609 | 14 | 66391 | 00998 | 1 | 99002 | 46 |
| 15 | 10 22 0 | 1 38 0 | 9.32670 | 14 | 10.67330 | 9.33670 | 15 | 10.66330 | 10.01000 | 1 | 9.99000 | 45 |
| 16 | 21 52 | 38 8 | 32728 | 15 | 67272 | 33731 | 16 | 66269 | 01003 | 1 | 98997 | 44 |
| 17 | 21 44 | 38 16 | 32786 | 16 | 67214 | 33792 | 17 | 66208 | 01006 | 1 | 98994 | 43 |
| 18 | 21 36 | 38 24 | 32844 | 17 | 67156 | 33853 | 18 | 66147 | 01009 | 1 | 98991 | 42 |
| 19 | 21 28 | 38 32 | 32902 | 18 | 67098 | 33913 | 19 | 66087 | 01011 | 1 | 98989 | 41 |
| 20 | 10 21 20 | 1 38 40 | 9.32960 | 19 | 10.67040 | 9.33974 | 20 | 10.66026 | 10.01014 | 1 | 9.98986 | 40 |
| 21 | 21 12 | 38 48 | 33018 | 20 | 66982 | 34034 | 21 | 65966 | 01017 | 1 | 98983 | 39 |
| 22 | 21 4 | 38 56 | 33075 | 21 | 66925 | 34095 | 22 | 65905 | 01020 | 1 | 98980 | 38 |
| 23 | 20 56 | 39 4 | 33133 | 22 | 66867 | 34155 | 23 | 65845 | 01022 | 1 | 98978 | 37 |
| 24 | 20 48 | 39 12 | 33190 | 23 | 66810 | 34215 | 24 | 65785 | 01025 | 1 | 98975 | 36 |
| 25 | 10 20 40 | 1 39 20 | 9.33248 | 24 | 10.66752 | 9.34276 | 25 | 10.65724 | 10.01028 | 1 | 9.98972 | 35 |
| 26 | 20 32 | 39 28 | 33305 | 25 | 66695 | 34336 | 26 | 65664 | 01031 | 1 | 98969 | 34 |
| 27 | 20 24 | 39 36 | 33362 | 26 | 66638 | 34396 | 27 | 65604 | 01033 | 1 | 98967 | 33 |
| 28 | 20 16 | 39 44 | 33420 | 27 | 66580 | 34456 | 28 | 65544 | 01036 | 1 | 98964 | 32 |
| 29 | 20 8 | 39 52 | 33477 | 28 | 66523 | 34516 | 29 | 65484 | 01039 | 1 | 98961 | 31 |
| 30 | 10 20 0 | 1 40 0 | 9.33534 | 29 | 10.66466 | 9.34576 | 30 | 10.65424 | 10.01042 | 1 | 9.98958 | 30 |
| 31 | 19 52 | 40 8 | 33591 | 29 | 66409 | 34635 | 31 | 65365 | 01045 | 1 | 98955 | 29 |
| 32 | 19 44 | 40 16 | 33647 | 30 | 66353 | 34695 | 32 | 65305 | 01047 | 1 | 98953 | 28 |
| 33 | 19 36 | 40 24 | 33704 | 31 | 66296 | 34755 | 33 | 65245 | 01050 | 2 | 98950 | 27 |
| 34 | 19 28 | 40 32 | 33761 | 32 | 66239 | 34814 | 34 | 65186 | 01053 | 2 | 98947 | 26 |
| 35 | 10 19 20 | 1 40 40 | 9.33818 | 33 | 10.66182 | 9.34874 | 35 | 10.65126 | 10.01056 | 2 | 9.98944 | 25 |
| 36 | 19 12 | 40 48 | 33874 | 34 | 66126 | 34933 | 36 | 65067 | 01059 | 2 | 98941 | 24 |
| 37 | 19 4 | 40 56 | 33931 | 35 | 66069 | 34992 | 37 | 65008 | 01062 | 2 | 98938 | 23 |
| 38 | 18 56 | 41 4 | 33987 | 36 | 66013 | 35051 | 38 | 64949 | 01064 | 2 | 98936 | 22 |
| 39 | 18 48 | 41 12 | 34043 | 37 | 65957 | 35111 | 39 | 64889 | 01067 | 2 | 98933 | 21 |
| 40 | 10 18 40 | 1 41 20 | 9.34100 | 38 | 10.65900 | 9.35170 | 40 | 10.64830 | 10.01070 | 2 | 9.98930 | 20 |
| 41 | 18 32 | 41 28 | 34156 | 39 | 65844 | 35229 | 41 | 64771 | 01073 | 2 | 98927 | 19 |
| 42 | 18 24 | 41 36 | 34212 | 40 | 65788 | 35288 | 42 | 64712 | 01076 | 2 | 98924 | 18 |
| 43 | 18 16 | 41 44 | 34268 | 41 | 65732 | 35347 | 43 | 64653 | 01079 | 2 | 98921 | 17 |
| 44 | 18 8 | 41 52 | 34324 | 42 | 65676 | 35405 | 44 | 64595 | 01081 | 2 | 98919 | 16 |
| 45 | 10 18 0 | 1 42 0 | 9.34380 | 43 | 10.65620 | 9.35464 | 45 | 10.64536 | 10.01084 | 2 | 9.98916 | 15 |
| 46 | 17 52 | 42 8 | 34436 | 44 | 65564 | 35523 | 46 | 64477 | 01087 | 2 | 98913 | 14 |
| 47 | 17 44 | 42 16 | 34491 | 45 | 65509 | 35581 | 47 | 64419 | 01090 | 2 | 98910 | 13 |
| 48 | 17 36 | 42 24 | 34547 | 46 | 65453 | 35640 | 48 | 64360 | 01093 | 2 | 98907 | 12 |
| 49 | 17 28 | 42 32 | 34602 | 47 | 65398 | 35698 | 49 | 64302 | 01096 | 2 | 98904 | 11 |
| 50 | 10 17 20 | 1 42 40 | 9.34658 | 48 | 10.65342 | 9.35757 | 50 | 10.64243 | 10.01099 | 2 | 9.98901 | 10 |
| 51 | 17 12 | 42 48 | 34713 | 48 | 65287 | 35815 | 51 | 64185 | 01102 | 2 | 98898 | 9 |
| 52 | 17 4 | 42 56 | 34769 | 49 | 65231 | 35873 | 52 | 64127 | 01104 | 2 | 98896 | 8 |
| 53 | 16 56 | 43 4 | 34824 | 50 | 65176 | 35931 | 53 | 64069 | 01107 | 2 | 98893 | 7 |
| 54 | 16 48 | 43 12 | 34879 | 51 | 65121 | 35989 | 54 | 64011 | 01110 | 3 | 98890 | 6 |
| 55 | 10 16 40 | 1 43 20 | 9.34934 | 52 | 10.65066 | 9.36047 | 55 | 10.63953 | 10.01113 | 3 | 9.98887 | 5 |
| 56 | 16 32 | 43 28 | 34989 | 53 | 65011 | 36105 | 56 | 63895 | 01116 | 3 | 98884 | 4 |
| 57 | 16 24 | 43 36 | 35044 | 54 | 64956 | 36163 | 57 | 63837 | 01119 | 3 | 98881 | 3 |
| 58 | 16 16 | 43 44 | 35099 | 55 | 64901 | 36221 | 58 | 63779 | 01122 | 3 | 98878 | 2 |
| 59 | 16 8 | 43 52 | 35154 | 56 | 64846 | 36279 | 59 | 63721 | 01125 | 3 | 98875 | 1 |
| 60 | 16 0 | 44 0 | 35209 | 57 | 64791 | 36336 | 60 | 63664 | 01128 | 3 | 98872 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |

**102°**     A    A    B    B    C    C    **77°**

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 7 | 14 | 21 | 29 | 36 | 43 | 50 |
| B | 7 | 15 | 22 | 30 | 37 | 45 | 52 |
| C | 0 | 1 | 1 | 1 | 2 | 2 | 2 |

TABLE 44. [Page 621

Log. Sines, Tangents, and Secants.

| 13° | | | A | | A | B | | B | C | | C | 166° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 10 16 0 | 1 44 0 | 9.35209 | 0 | 10.64791 | 9.36336 | 0 | 10.63664 | 10.01128 | 0 | 9.98872 | 60 |
| 1 | 15 52 | 44 8 | 35263 | 1 | 64737 | 36394 | 1 | 63606 | 01131 | 0 | 98869 | 59 |
| 2 | 15 44 | 44 16 | 35318 | 2 | 64682 | 36452 | 2 | 63548 | 01133 | 0 | 98867 | 58 |
| 3 | 15 36 | 44 24 | 35373 | 3 | 64627 | 36509 | 3 | 63491 | 01136 | 0 | 98864 | 57 |
| 4 | 15 28 | 44 32 | 35427 | 4 | 64573 | 36566 | 4 | 63434 | 01139 | 0 | 98861 | 56 |
| 5 | 10 15 20 | 1 44 40 | 9.35481 | 4 | 10.64519 | 9.36624 | 5 | 10.63376 | 10.01142 | 0 | 9.98858 | 55 |
| 6 | 15 12 | 44 48 | 35536 | 5 | 64464 | 36681 | 6 | 63319 | 01145 | 0 | 98855 | 54 |
| 7 | 15 4 | 44 56 | 35590 | 6 | 64410 | 36738 | 6 | 63262 | 01148 | 0 | 98852 | 53 |
| 8 | 14 56 | 45 4 | 35644 | 7 | 64356 | 36795 | 7 | 63205 | 01151 | 0 | 98849 | 52 |
| 9 | 14 48 | 45 12 | 35698 | 8 | 64302 | 36852 | 8 | 63148 | 01154 | 0 | 98846 | 51 |
| 10 | 10 14 40 | 1 45 20 | 9.35752 | 9 | 10.64248 | 9.36909 | 9 | 10.63091 | 10.01157 | 1 | 9.98843 | 50 |
| 11 | 14 32 | 45 28 | 35806 | 10 | 64194 | 36966 | 10 | 63034 | 01160 | 1 | 98840 | 49 |
| 12 | 14 24 | 45 36 | 35860 | 11 | 64140 | 37023 | 11 | 62977 | 01163 | 1 | 98837 | 48 |
| 13 | 14 16 | 45 44 | 35914 | 11 | 64086 | 37080 | 12 | 62920 | 01166 | 1 | 98834 | 47 |
| 14 | 14 8 | 45 52 | 35968 | 12 | 64032 | 37137 | 13 | 62863 | 01169 | 1 | 98831 | 46 |
| 15 | 10 14 0 | 1 46 0 | 9.36022 | 13 | 10.63978 | 9.37193 | 14 | 10.62807 | 10.01172 | 1 | 9.98828 | 45 |
| 16 | 13 52 | 46 8 | 36075 | 14 | 63925 | 37250 | 15 | 62750 | 01175 | 1 | 98825 | 44 |
| 17 | 13 44 | 46 16 | 36129 | 15 | 63871 | 37306 | 16 | 62694 | 01178 | 1 | 98822 | 43 |
| 18 | 13 36 | 46 24 | 36182 | 16 | 63818 | 37363 | 17 | 62637 | 01181 | 1 | 98819 | 42 |
| 19 | 13 28 | 46 32 | 36236 | 17 | 63764 | 37419 | 18 | 62581 | 01184 | 1 | 98816 | 41 |
| 20 | 10 13 20 | 1 46 40 | 9.36289 | 18 | 10.63711 | 9.37476 | 19 | 10.62524 | 10.01187 | 1 | 9.98813 | 40 |
| 21 | 13 12 | 46 48 | 36342 | 18 | 63658 | 37532 | 19 | 62468 | 01190 | 1 | 98810 | 39 |
| 22 | 13 4 | 46 56 | 36395 | 19 | 63605 | 37588 | 20 | 62412 | 01193 | 1 | 98807 | 38 |
| 23 | 12 56 | 47 4 | 36449 | 20 | 63551 | 37644 | 21 | 62356 | 01196 | 1 | 98804 | 37 |
| 24 | 12 48 | 47 12 | 36502 | 21 | 63498 | 37700 | 22 | 62300 | 01199 | 1 | 98801 | 36 |
| 25 | 10 12 40 | 1 47 20 | 9.36555 | 22 | 10.63445 | 9.37756 | 23 | 10.62244 | 10.01202 | 1 | 9.98798 | 35 |
| 26 | 12 32 | 47 28 | 36608 | 23 | 63392 | 37812 | 24 | 62188 | 01205 | 1 | 98795 | 34 |
| 27 | 12 24 | 47 36 | 36660 | 24 | 63340 | 37868 | 25 | 62132 | 01208 | 1 | 98792 | 33 |
| 28 | 12 16 | 47 44 | 36713 | 25 | 63287 | 37924 | 26 | 62076 | 01211 | 1 | 98789 | 32 |
| 29 | 12 8 | 47 52 | 36766 | 25 | 63234 | 37980 | 27 | 62020 | 01214 | 1 | 98786 | 31 |
| 30 | 10 12 0 | 1 48 0 | 9.36819 | 26 | 10.63181 | 9.38035 | 28 | 10.61965 | 10.01217 | 2 | 9.98783 | 30 |
| 31 | 11 52 | 48 8 | 36871 | 27 | 63129 | 38091 | 29 | 61909 | 01220 | 2 | 98780 | 29 |
| 32 | 11 44 | 48 16 | 36924 | 28 | 63076 | 38147 | 30 | 61853 | 01223 | 2 | 98777 | 28 |
| 33 | 11 36 | 48 24 | 36976 | 29 | 63024 | 38202 | 31 | 61798 | 01226 | 2 | 98774 | 27 |
| 34 | 11 28 | 48 32 | 37028 | 30 | 62972 | 38257 | 32 | 61743 | 01229 | 2 | 98771 | 26 |
| 35 | 10 11 20 | 1 48 40 | 9.37081 | 31 | 10.62919 | 9.38313 | 32 | 10.61687 | 10.01232 | 2 | 9.98768 | 25 |
| 36 | 11 12 | 48 48 | 37133 | 32 | 62867 | 38368 | 33 | 61632 | 01235 | 2 | 98765 | 24 |
| 37 | 11 4 | 48 56 | 37185 | 32 | 62815 | 38423 | 34 | 61577 | 01238 | 2 | 98762 | 23 |
| 38 | 10 56 | 49 4 | 37237 | 33 | 62763 | 38479 | 35 | 61521 | 01241 | 2 | 98759 | 22 |
| 39 | 10 48 | 49 12 | 37289 | 34 | 62711 | 38534 | 36 | 61466 | 01244 | 2 | 98756 | 21 |
| 40 | 10 10 40 | 1 49 20 | 9.37341 | 35 | 10.62659 | 9.38589 | 37 | 10.61411 | 10.01247 | 2 | 9.98753 | 20 |
| 41 | 10 32 | 49 28 | 37393 | 36 | 62607 | 38644 | 38 | 61356 | 01250 | 2 | 98750 | 19 |
| 42 | 10 24 | 49 36 | 37445 | 37 | 62555 | 38699 | 39 | 61301 | 01254 | 2 | 98746 | 18 |
| 43 | 10 16 | 49 44 | 37497 | 38 | 62503 | 38754 | 40 | 61246 | 01257 | 2 | 98743 | 17 |
| 44 | 10 8 | 49 52 | 37549 | 39 | 62451 | 38808 | 41 | 61192 | 01260 | 2 | 98740 | 16 |
| 45 | 10 10 0 | 1 50 0 | 9.37600 | 39 | 10.62400 | 9.38863 | 42 | 10.61137 | 10.01263 | 2 | 9.98737 | 15 |
| 46 | 9 52 | 50 8 | 37652 | 40 | 62348 | 38918 | 43 | 61082 | 01266 | 2 | 98734 | 14 |
| 47 | 9 44 | 50 16 | 37703 | 41 | 62297 | 38972 | 44 | 61028 | 01269 | 2 | 98731 | 13 |
| 48 | 9 36 | 50 24 | 37755 | 42 | 62245 | 39027 | 45 | 60973 | 01272 | 2 | 98728 | 12 |
| 49 | 9 28 | 50 32 | 37806 | 43 | 62194 | 39082 | 45 | 60918 | 01275 | 2 | 98725 | 11 |
| 50 | 10 9 20 | 1 50 40 | 9.37858 | 44 | 10.62142 | 9.39136 | 46 | 10.60864 | 10.01278 | 3 | 9.98722 | 10 |
| 51 | 9 12 | 50 48 | 37909 | 45 | 62091 | 39190 | 47 | 60810 | 01281 | 3 | 98719 | 9 |
| 52 | 9 4 | 50 56 | 37960 | 46 | 62040 | 39245 | 48 | 60755 | 01285 | 3 | 98715 | 8 |
| 53 | 8 56 | 51 4 | 38011 | 47 | 61989 | 39299 | 49 | 60701 | 01288 | 3 | 98712 | 7 |
| 54 | 8 48 | 51 12 | 38062 | 47 | 61938 | 39353 | 50 | 60647 | 01291 | 3 | 98709 | 6 |
| 55 | 10 8 40 | 1 51 20 | 9.38113 | 48 | 10.61887 | 9.39407 | 51 | 10.60593 | 10.01294 | 3 | 9.98706 | 5 |
| 56 | 8 32 | 51 28 | 38164 | 49 | 61836 | 39461 | 52 | 60539 | 01297 | 3 | 98703 | 4 |
| 57 | 8 24 | 51 36 | 38215 | 50 | 61785 | 39515 | 53 | 60485 | 01300 | 3 | 98700 | 3 |
| 58 | 8 16 | 51 44 | 38266 | 51 | 61734 | 39569 | 54 | 60431 | 01303 | 3 | 98697 | 2 |
| 59 | 8 8 | 51 52 | 38317 | 52 | 61683 | 39623 | 55 | 60377 | 01306 | 3 | 98694 | 1 |
| 60 | 8 0 | 52 0 | 38368 | 53 | 61632 | 39677 | 56 | 60323 | 01310 | 3 | 98690 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 103° | | | A | | A | B | | B | C | | C | 76° |

| Seconds of time ........ | | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|---|
| Prop. parts of cols. | A | 7 | 13 | 20 | 26 | 33 | 39 | 46 |
| | B | 7 | 14 | 21 | 28 | 35 | 42 | 49 |
| | C | 0 | 1 | 1 | 2 | 2 | 2 | 3 |

# TABLE 44.

### Log. Sines, Tangents, and Secants.

| 14° | | | A | | A | B | | B. | C | . | C | 165° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 10  8   0 | 1 52   0 | 9.38368 | 0 | 10.61632 | 9.39677 | 0 | 10.60323 | 10.01310 | 0 | 9.98690 | 60 |
| 1 | 7 52 | 52   8 | 38418 | 1 | 61582 | 39731 | 1 | 60269 | 01313 | 0 | 98687 | 59 |
| 2 | 7 44 | 52 16 | 38469 | 2 | 61531 | 39785 | 2 | 60215 | 01316 | 0 | 98684 | 58 |
| 3 | 7 36 | 52 24 | 38519 | 2 | 61481 | 39838 | 3 | 60162 | 01319 | 0 | 98681 | 57 |
| 4 | 7 28 | 52 32 | 38570 | 3 | 61430 | 39892 | 3 | 60108 | 01322 | 0 | 98678 | 56 |
| 5 | 10  7 20 | 1 52 40 | 38620 | 4 | 10.61380 | 9.39945 | 4 | 10.60055 | 10.01325 | 0 | 9.98675 | 55 |
| 6 | 7 12 | 52 48 | 38670 | 5 | 61330 | 39999 | 5 | 60001 | 01329 | 0 | 98671 | 54 |
| 7 | 7  4 | 52 56 | 38721 | 6 | 61279 | 40052 | 6 | 59948 | 01332 | 0 | 98668 | 53 |
| 8 | 6 56 | 53   4 | 38771 | 7 | 61229 | 40106 | 7 | 59894 | 01335 | 0 | 98665 | 52 |
| 9 | 6 48 | 53 12 | 38821 | 7 | 61179 | 40159 | 8 | 59841 | 01338 | 0 | 98662 | 51 |
| 10 | 10  6 40 | 1 53 20 | 9.38871 | 8 | 10.61129 | 9.40212 | 9 | 10.59788 | 10.01341 | 1 | 9.98659 | 50 |
| 11 | 6 32 | 53 28 | 38921 | 9 | 61079 | 40266 | 10 | 59734 | 01344 | 1 | 98656 | 49 |
| 12 | 6 24 | 53 36 | 38971 | 10 | 61029 | 40319 | 10 | 59681 | 01348 | 1 | 98652 | 48 |
| 13 | 6 16 | 53 44 | 39021 | 11 | 60979 | 40372 | 11 | 59628 | 01351 | 1 | 98649 | 47 |
| 14 | 6  8 | 53 52 | 39071 | 11 | 60929 | 40425 | 12 | 59575 | 01354 | 1 | 98646 | 46 |
| 15 | 10  6  0 | 1 54  0 | 9.39121 | 12 | 10.60879 | 9.40478 | 13 | 10.59522 | 10.01357 | 1 | 9.98643 | 45 |
| 16 | 5 52 | 54   8 | 39170 | 13 | 60830 | 40531 | 14 | 59469 | 01360 | 1 | 98640 | 44 |
| 17 | 5 44 | 54 16 | 39220 | 14 | 60780 | 40584 | 15 | 59416 | 01364 | 1 | 98636 | 43 |
| 18 | 5 36 | 54 24 | 39270 | 15 | 60730 | 40636 | 16 | 59364 | 01367 | 1 | 98633 | 42 |
| 19 | 5 28 | 54 32 | 39319 | 15 | 60681 | 40689 | 17 | 59311 | 01370 | 1 | 98630 | 41 |
| 20 | 10  5 20 | 1 54 40 | 9.39369 | 16 | 10.60631 | 9.40742 | 17 | 10.59258 | 10.01373 | 1 | 9.98627 | 40 |
| 21 | 5 12 | 54 48 | 39418 | 17 | 60582 | 40795 | 18 | 59205 | 01377 | 1 | 98623 | 39 |
| 22 | 5  4 | 54 56 | 39467 | 18 | 60533 | 40847 | 19 | 59153 | 01380 | 1 | 98620 | 38 |
| 23 | 4 56 | 55   4 | 39517 | 19 | 60483 | 40900 | 20 | 59100 | 01383 | 1 | 98617 | 37 |
| 24 | 4 48 | 55 12 | 39566 | 20 | 60434 | 40952 | 21 | 59048 | 01386 | 1 | 98614 | 36 |
| 25 | 10  4 40 | 1 55 20 | 9.39615 | 20 | 10.60385 | 9.41005 | 22 | 10.58995 | 10.01390 | 1 | 9.98610 | 35 |
| 26 | 4 32 | 55 28 | 39664 | 21 | 60336 | 41057 | 23 | 58943 | 01393 | 1 | 98607 | 34 |
| 27 | 4 24 | 55 36 | 39713 | 22 | 60287 | 41109 | 23 | 58891 | 01396 | 1 | 98604 | 33 |
| 28 | 4 16 | 55 44 | 39762 | 23 | 60238 | 41161 | 24 | 58839 | 01399 | 2 | 98601 | 32 |
| 29 | 4  8 | 55 52 | 39811 | 24 | 60189 | 41214 | 25 | 58786 | 01403 | 2 | 98597 | 31 |
| 30 | 10  4  0 | 1 56  0 | 9.39860 | 24 | 10.60140 | 9.41266 | 26 | 10.58734 | 10.01406 | 2 | 9.98594 | 30 |
| 31 | 3 52 | 56   8 | 39909 | 25 | 60091 | 41318 | 27 | 58682 | 01409 | 2 | 98591 | 29 |
| 32 | 3 44 | 56 16 | 39958 | 26 | 60042 | 41370 | 28 | -58630 | 01412 | 2 | 98588 | 28 |
| 33 | 3 36 | 56 24 | 40006 | 27 | 59994 | 41422 | 29 | 58578 | 01416 | 2 | 98584 | 27 |
| 34 | 3 28 | 56 32 | 40055 | 28 | 59945 | 41474 | 30 | 58526 | 01419 | 2 | 98581 | 26 |
| 35 | 10  3 20 | 1 56 40 | 9.40103 | 29 | 10.59897 | 9.41526 | 30 | 10.58474 | 01422 | 2 | 9.98578 | 25 |
| 36 | 3 12 | 56 48 | 40152 | 29 | 59848 | 41578 | 31 | 58422 | 01426 | 2 | 98574 | 24 |
| 37 | 3  4 | 56 56 | 40200 | 30 | 59800 | 41629 | 32 | 58371 | 01429 | 2 | 98571 | 23 |
| 38 | 2 56 | 57   4 | 40249 | 31 | 59751 | 41681 | 33 | 58319 | 01432 | 2 | 98568 | 22 |
| 39 | 2 48 | 57 12 | 40297 | 32 | 59703 | 41733 | 34 | 58267 | 01435 | 2 | 98565 | 21 |
| 40 | 10  2 40 | 1 57 20 | 9.40346 | 33 | 10.59654 | 9.41784 | 35 | 10.58216 | 10.01439 | 2 | 9.98561 | 20 |
| 41 | 2 32 | 57 28 | 40394 | 33 | 59606 | 41836 | 36 | 58164 | 01442 | 2 | 98558 | 19 |
| 42 | 2 24 | 57 36 | 40442 | 34 | 59558 | 41887 | 36 | 58113 | 01445 | 2 | 98555 | 18 |
| 43 | 2 16 | 57 44 | 40490 | 35 | 59510 | 41939 | 37 | 58061 | 01449 | 2 | 98551 | 17 |
| 44 | 2  8 | 57 52 | 40538 | 36 | 59462 | 41990 | 38 | 58010 | 01452 | 2 | 98548 | 16 |
| 45 | 10  2  0 | 1 58  0 | 9.40586 | 37 | 10.59414 | 9.42041 | 39 | 10.57959 | 10.01455 | 2 | 9.98545 | 15 |
| 46 | 1 52 | 58   8 | 40634 | 37 | 59366 | 42093 | 40 | 57907 | 01459 | 3 | 98541 | 14 |
| 47 | 1 44 | 58 16 | 40682 | 38 | 59318 | 42144 | 41 | 57856 | 01462 | 3 | 98538 | 13 |
| 48 | 1 36 | 58 24 | 40730 | 39 | 59270 | 42195 | 42 | 57805 | 01465 | 3 | 98535 | 12 |
| 49 | 1 28 | 58 32 | 40778 | 40 | 59222 | 42246 | 43 | 57754 | 01469 | 3 | 98531 | 11 |
| 50 | 10  1 20 | 1 58 40 | 9.40825 | 41 | 10.59175 | 9.42297 | 43 | 10.57703 | 10.01472 | 3 | 9.98528 | 10 |
| 51 | 1 12 | 58 48 | 40873 | 42 | 59127 | 42348 | 44 | 57652 | 01475 | 3 | 98525 | 9 |
| 52 | 1  4 | 58 56 | 40921 | 42 | 59079 | 42399 | 45 | 57601 | 01479 | 3 | 98521 | 8 |
| 53 | 0 56 | 59   4 | 40968 | 43 | 59032 | 42450 | 46 | 57550 | 01482 | 3 | 98518 | 7 |
| 54 | 0 48 | 59 12 | 41016 | 44 | 58984 | 42501 | 47 | 57499 | 01485 | 3 | 98515 | 6 |
| 55 | 10  0 40 | 1 59 20 | 9.41063 | 45 | 10.58937 | 9.42552 | 48 | 10.57448 | 10.01489 | 3 | 9.98511 | 5 |
| 56 | 0 32 | 59 28 | 41111 | 46 | 58889 | 42603 | 49 | 57397 | 01492 | 3 | 98508 | 4 |
| 57 | 0 24 | 59 36 | 41158 | 46 | 58842 | 42653 | 50 | 57347 | 01495 | 3 | 98505 | 3 |
| 58 | 0 16 | 59 44 | 41205 | 47 | 58795 | 42704 | 50 | 57296 | 01499 | 3 | 98501 | 2 |
| 59 | 0  8 | 59 52 | 41252 | 48 | 58748 | 42755 | 51 | 57245 | 01502 | 3 | 98498 | 1 |
| 60 | 0  0 | 2  0  0 | 41300 | 49 | 58700 | 42805 | 52 | 57195 | 01506 | 3 | 98494 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 104° | | | A | | A | B | | B | C | | C | 75° |

| Seconds of time ....... | 1s | 2s | 3s | 4s | 5s | 6s | 7s |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 6 | 12 | 18 | 24 | 31 | 37 | 43 |
| B | 7 | 13 | 20 | 26 | 33 | 39 | 46 |
| C | 0 | 1 | 1 | 2 | 2 | 2 | 3 |

TABLE 44. [Page 623

Log. Sines, Tangents, and Secants.

| 15° | | | A | | A | B | | B | C | | C | 164° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 10 0 0 | 2 0 0 | 9.41300 | 0 | 10.58700 | 9.42805 | 0 | 10.57195 | 10.01506 | 0 | 9.98494 | 60 |
| 1 | 9 59 52 | 0 8 | 41347 | 1 | 58653 | 42856 | 1 | 57144 | 01509 | 0 | 98491 | 59 |
| 2 | 59 44 | 0 16 | 41394 | 2 | 58606 | 42906 | 2 | 57094 | 01512 | 0 | 98488 | 58 |
| 3 | 59 36 | 0 24 | 41441 | 2 | 58559 | 42957 | 2 | 57043 | 01516 | 0 | 98484 | 57 |
| 4 | 59 28 | 0 32 | 41488 | 3 | 58512 | 43007 | 3 | 56993 | 01519 | 0 | 98481 | 56 |
| 5 | 9 59 20 | 2 0 40 | 9.41535 | 4 | 10.58465 | 9.43057 | 4 | 10.56943 | 10.01523 | 0 | 9.98477 | 55 |
| 6 | 59 12 | 0 48 | 41582 | 5 | 58418 | 43108 | 5 | 56892 | 01526 | 0 | 98474 | 54 |
| 7 | 59 4 | 0 56 | 41628 | 5 | 58372 | 43158 | 6 | 56842 | 01529 | 0 | 98471 | 53 |
| 8 | 58 56 | 1 4 | 41675 | 6 | 58325 | 43208 | 7 | 56792 | 01533 | 0 | 98467 | 52 |
| 9 | 58 48 | 1 12 | 41722 | 7 | 58278 | 43258 | 7 | 56742 | 01536 | 1 | 98464 | 51 |
| 10 | 9 58 40 | 2 1 20 | 9.41768 | 8 | 10.58232 | 9.43308 | 8 | 10.56692 | 10.01540 | 1 | 9.98460 | 50 |
| 11 | 58 32 | 1 28 | 41815 | 8 | 58185 | 43358 | 9 | 56642 | 01543 | 1 | 98457 | 49 |
| 12 | 58 24 | 1 36 | 41861 | 9 | 58139 | 43408 | 10 | 56592 | 01547 | 1 | 98453 | 48 |
| 13 | 58 16 | 1 44 | 41908 | 10 | 58092 | 43458 | 11 | 56542 | 01550 | 1 | 98450 | 47 |
| 14 | 58 8 | 1 52 | 41954 | 11 | 58046 | 43508 | 11 | 56492 | 01553 | 1 | 98447 | 46 |
| 15 | 9 58 0 | 2 2 0 | 9.42001 | 11 | 10.57999 | 9.43558 | 12 | 10.56442 | 10.01557 | 1 | 9.98443 | 45 |
| 16 | 57 52 | 2 8 | 42047 | 12 | 57953 | 43607 | 13 | 56393 | 01560 | 1 | 98440 | 44 |
| 17 | 57 44 | 2 16 | 42093 | 13 | 57907 | 43657 | 14 | 56343 | 01564 | 1 | 98436 | 43 |
| 18 | 57 36 | 2 24 | 42140 | 14 | 57860 | 43707 | 15 | 56293 | 01567 | 1 | 98433 | 42 |
| 19 | 57 28 | 2 32 | 42186 | 14 | 57814 | 43756 | 16 | 56244 | 01571 | 1 | 98429 | 41 |
| 20 | 9 57 20 | 2 2 40 | 9.42232 | 15 | 10.57768 | 9.43806 | 16 | 10.56194 | 10.01574 | 1 | 9.98426 | 40 |
| 21 | 57 12 | 2 48 | 42278 | 16 | 57722 | 43855 | 17 | 56145 | 01578 | 1 | 98422 | 39 |
| 22 | 57 4 | 2 56 | 42324 | 17 | 57676 | 43905 | 18 | 56095 | 01581 | 1 | 98419 | 38 |
| 23 | 56 56 | 3 4 | 42370 | 17 | 57630 | 43954 | 19 | 56046 | 01585 | 1 | 98415 | 37 |
| 24 | 56 48 | 3 12 | 42416 | 18 | 57584 | 44004 | 20 | 55996 | 01588 | 1 | 98412 | 36 |
| 25 | 9 56 40 | 2 3 20 | 9.42461 | 19 | 10.57539 | 9.44053 | 20 | 10.55947 | 10.01591 | 1 | 9.98409 | 35 |
| 26 | 56 32 | 3 28 | 42507 | 20 | 57493 | 44102 | 21 | 55898 | 01595 | 2 | 98405 | 34 |
| 27 | 56 24 | 3 36 | 42553 | 21 | 57447 | 44151 | 22 | 55849 | 01598 | 2 | 98402 | 33 |
| 28 | 56 16 | 3 44 | 42599 | 21 | 57401 | 44201 | 23 | 55799 | 01602 | 2 | 98398 | 32 |
| 29 | 56 8 | 3 52 | 42644 | 22 | 57356 | 44250 | 24 | 55750 | 01605 | 2 | 98395 | 31 |
| 30 | 9 56 0 | 2 4 0 | 9.42690 | 23 | 10.57310 | 9.44299 | 25 | 10.55701 | 10.01609 | 2 | 9.98391 | 30 |
| 31 | 55 52 | 4 8 | 42735 | 24 | 57265 | 44348 | 25 | 55652 | 01612 | 2 | 98388 | 29 |
| 32 | 55 44 | 4 16 | 42781 | 24 | 57219 | 44397 | 26 | 55603 | 01616 | 2 | 98384 | 28 |
| 33 | 55 36 | 4 24 | 42826 | 25 | 57174 | 44446 | 27 | 55554 | 01619 | 2 | 98381 | 27 |
| 34 | 55 28 | 4 32 | 42872 | 26 | 57128 | 44495 | 28 | 55505 | 01623 | 2 | 98377 | 26 |
| 35 | 9 55 20 | 2 4 40 | 9.42917 | 27 | 10.57083 | 9.44544 | 29 | 10.55456 | 10.01627 | 2 | 9.98373 | 25 |
| 36 | 55 12 | 4 48 | 42962 | 27 | 57038 | 44592 | 29 | 55408 | 01630 | 2 | 98370 | 24 |
| 37 | 55 4 | 4 56 | 43008 | 28 | 56992 | 44641 | 30 | 55359 | 01634 | 2 | 98366 | 23 |
| 38 | 54 56 | 5 4 | 43053 | 29 | 56947 | 44690 | 31 | 55310 | 01637 | 2 | 98363 | 22 |
| 39 | 54 48 | 5 12 | 43098 | 30 | 56902 | 44738 | 32 | 55262 | 01641 | 2 | 98359 | 21 |
| 40 | 9 54 40 | 2 5 20 | 9.43143 | 30 | 10.56857 | 9.44787 | 33 | 10.55213 | 10.01644 | 2 | 9.98356 | 20 |
| 41 | 54 32 | 5 28 | 43188 | 31 | 56812 | 44836 | 34 | 55164 | 01648 | 2 | 98352 | 19 |
| 42 | 54 24 | 5 36 | 43233 | 32 | 56767 | 44884 | 34 | 55116 | 01651 | 2 | 98349 | 18 |
| 43 | 54 16 | 5 44 | 43278 | 33 | 56722 | 44933 | 35 | 55067 | 01655 | 3 | 98345 | 17 |
| 44 | 54 8 | 5 52 | 43323 | 33 | 56677 | 44981 | 36 | 55019 | 01658 | 3 | 98342 | 16 |
| 45 | 9 54 0 | 2 6 0 | 9.43367 | 34 | 10.56633 | 9.45029 | 37 | 10.54971 | 10.01662 | 3 | 9.98338 | 15 |
| 46 | 53 52 | 6 8 | 43412 | 35 | 56588 | 45078 | 38 | 54922 | 01666 | 3 | 98334 | 14 |
| 47 | 53 44 | 6 16 | 43457 | 36 | 56543 | 45126 | 38 | 54874 | 01669 | 3 | 98331 | 13 |
| 48 | 53 36 | 6 24 | 43502 | 36 | 56498 | 45174 | 39 | 54826 | 01673 | 3 | 98327 | 12 |
| 49 | 53 28 | 6 32 | 43546 | 37 | 56454 | 45222 | 40 | 54778 | 01676 | 3 | 98324 | 11 |
| 50 | 9 53 20 | 2 6 40 | 9.43591 | 38 | 10.56409 | 9.45271 | 41 | 10.54729 | 10.01680 | 3 | 9.98320 | 10 |
| 51 | 53 12 | 6 48 | 43635 | 39 | 56365 | 45319 | 42 | 54681 | 01683 | 3 | 98317 | 9 |
| 52 | 53 4 | 6 56 | 43680 | 39 | 56320 | 45367 | 43 | 54633 | 01687 | 3 | 98313 | 8 |
| 53 | 52 56 | 7 4 | 43724 | 40 | 56276 | 45415 | 43 | 54585 | 01691 | 3 | 98309 | 7 |
| 54 | 52 48 | 7 12 | 43769 | 41 | 56231 | 45463 | 44 | 54537 | 01694 | 3 | 98306 | 6 |
| 55 | 9 52 40 | 2 7 20 | 9.43813 | 42 | 10.56187 | 9.45511 | 45 | 10.54489 | 10.01698 | 3 | 9.98302 | 5 |
| 56 | 52 32 | 7 28 | 43857 | 43 | 56143 | 45559 | 46 | 54441 | 01701 | 3 | 98299 | 4 |
| 57 | 52 24 | 7 36 | 43901 | 43 | 56099 | 45606 | 47 | 54394 | 01705 | 3 | 98295 | 3 |
| 58 | 52 16 | 7 44 | 43946 | 44 | 56054 | 45654 | 47 | 54346 | 01709 | 3 | 98291 | 2 |
| 59 | 52 8 | 7 52 | 43990 | 45 | 56010 | 45702 | 48 | 54298 | 01712 | 3 | 98288 | 1 |
| 60 | 52 0 | 8 0 | 44034 | 46 | 55966 | 45750 | 49 | 54250 | 01716 | 4 | 98284 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 105° | | | A | | A | B | | B | C | | C | 74° |

| Seconds of time ....... | | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|---|
| Prop. parts of cols. | A | 6 | 11 | 17 | 23 | 28 | 34 | 40 |
| | B | 6 | 12 | 18 | 25 | 31 | 37 | 43 |
| | C | 0 | 1 | 1 | 2 | 2 | 3 | 3 |

# TABLE 44.

### Log. Sines, Tangents, and Secants.

| 16° | | | A | | A | B | | B | C | | C | 163° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 9 52 0 | 2 8 0 | 9.44034 | 0 | 10.55966 | 9.45750 | 0 | 10.54250 | 10.01716 | 0 | 9.98284 | 60 |
| 1 | 51 52 | 8 8 | 44078 | 1 | 55922 | 45797 | 1 | 54203 | 01719 | 0 | 98281 | 59 |
| 2 | 51 44 | 8 16 | 44122 | 1 | 55878 | 45845 | 2 | 54155 | 01723 | 0 | 98277 | 58 |
| 3 | 51 36 | 8 24 | 44166 | 2 | 55834 | 45892 | 2 | 54108 | 01727 | 0 | 98273 | 57 |
| 4 | 51 28 | 8 32 | 44210 | 3 | 55790 | 45940 | 3 | 54060 | 01730 | 0 | 98270 | 56 |
| 5 | 9 51 20 | 2 8 40 | 9.44253 | 4 | 10.55747 | 9.45987 | 4 | 10.54013 | 10.01734 | 0 | 9.98266 | 55 |
| 6 | 51 12 | 8 48 | 44297 | 4 | 55703 | 46035 | 5 | 53965 | 01738 | 0 | 98262 | 54 |
| 7 | 51 4 | 8 56 | 44341 | 5 | 55659 | 46082 | 5 | 53918 | 01741 | 0 | 98259 | 53 |
| 8 | 50 56 | 9 4 | 44385 | 6 | 55615 | 46130 | 6 | 53870 | 01745 | 0 | 98255 | 52 |
| 9 | 50 48 | 9 12 | 44428 | 6 | 55572 | 46177 | 7 | 53823 | 01749 | 1 | 98251 | 51 |
| 10 | 9 50 40 | 2 9 20 | 9.44472 | 7 | 10.55528 | 9.46224 | 8 | 10.53776 | 10.01752 | 1 | 9.98248 | 50 |
| 11 | 50 32 | 9 28 | 44516 | 8 | 55484 | 46271 | 9 | 53729 | 01756 | 1 | 98244 | 49 |
| 12 | 50 24 | 9 36 | 44559 | 9 | 55441 | 46319 | 9 | 53681 | 01760 | 1 | 98240 | 48 |
| 13 | 50 16 | 9 44 | 44602 | 9 | 55398 | 46366 | 10 | 53634 | 01763 | 1 | 98237 | 47 |
| 14 | 50 8 | 9 52 | 44646 | 10 | 55354 | 46413 | 11 | 53587 | 01767 | 1 | 98233 | 46 |
| 15 | 9 50 0 | 2 10 0 | 9.44689 | 11 | 10.55311 | 9.46460 | 12 | 10.53540 | 10.01771 | 1 | 9.98229 | 45 |
| 16 | 49 52 | 10 8 | 44733 | 11 | 55267 | 46507 | 12 | 53493 | 01774 | 1 | 98226 | 44 |
| 17 | 49 44 | 10 16 | 44776 | 12 | 55224 | 46554 | 13 | 53446 | 01778 | 1 | 98222 | 43 |
| 18 | 49 36 | 10 24 | 44819 | 13 | 55181 | 46601 | 14 | 53399 | 01782 | 1 | 98218 | 42 |
| 19 | 49 28 | 10 32 | 44862 | 14 | .55138 | 46648 | 15 | 53352 | 01785 | 1 | 98215 | 41 |
| 20 | 9 49 20 | 2 10 40 | 9.44905 | 14 | 10.55095 | 9.46694 | 15 | 10.53306 | 10.01789 | 1 | 9.98211 | 40 |
| 21 | 49 12 | 10 48 | 44948 | 15 | 55052 | 46741 | 16 | 53259 | 01793 | 1 | 98207 | 39 |
| 22 | 49 4 | 10 56 | 44992 | 16 | 55008 | 46788 | 17 | 53212 | 01796 | 1 | 98204 | 38 |
| 23 | 48 56 | 11 4 | 45035 | 16 | 54965 | 46835 | 18 | 53165 | 01800 | 1 | 98200 | 37 |
| 24 | 48 48 | 11 12 | 45077 | 17 | 54923 | 46881 | 19 | 53119 | 01804 | 1 | 98196 | 36 |
| 25 | 9 48 40 | 2 11 20 | 9.45120 | 18 | 10.54880 | 9.46928 | 19 | 10.53072 | 10.01808 | 2 | 9.98192 | 35 |
| 26 | 48 32 | 11 28 | 45163 | 18 | 54837 | 46975 | 20 | 53025 | 01811 | 2 | 98189 | 34 |
| 27 | 48 24 | 11 36 | 45206 | 19 | 54794 | 47021 | 21 | 52979 | 01815 | 2 | 98185 | 33 |
| 28 | 48 16 | 11 44 | 45249 | 20 | 54751 | 47068 | 22 | 52932 | 01819 | 2 | 98181 | 32 |
| 29 | 48 8 | 11 52 | 45292 | 21 | 54708 | 47114 | 22 | 52886 | 01823 | 2 | 98177 | 31 |
| 30 | 9 48 0 | 2 12 0 | 9.45334 | 21 | 10.54666 | 9.47160 | 23 | 10.52840 | 10.01826 | 2 | 9.98174 | 30 |
| 31 | 47 52 | 12 8 | 45377 | 22 | 54623 | 47207 | 24 | 52793 | 01830 | 2 | 98170 | 29 |
| 32 | 47 44 | 12 16 | 45419 | 23 | 54581 | 47253 | 25 | 52747 | 01834 | 2 | 98166 | 28 |
| 33 | 47 36 | 12 24 | 45462 | 23 | 54538 | 47299 | 26 | 52701 | 01838 | 2 | 98162 | 27 |
| 34 | 47 28 | 12 32 | 45504 | 24 | 54496 | 47346 | 26 | 52654 | 01841 | 2 | 98159 | 26 |
| 35 | 9 47 20 | 2 12 40 | 9.45547 | 25 | 10.54453 | 9.47392 | 27 | 10.52608 | 10.01845 | 2 | 9.98155 | 25 |
| 36 | 47 12 | 12 48 | 45589 | 26 | 54411 | 47438 | 28 | 52562 | 01849 | 2 | 98151 | 24 |
| 37 | 47 4 | 12 56 | 45632 | 26 | 54368 | 47484 | 29 | 52516 | 01853 | 2 | 98147 | 23 |
| 38 | 46 56 | 13 4 | 45674 | 27 | 54326 | 47530 | 29 | 52470 | 01856 | 2 | 98144 | 22 |
| 39 | 46 48 | 13 12 | 45716 | 28 | 54284 | 47576 | 30 | 52424 | 01860 | 2 | 98140 | 21 |
| 40 | 9 46 40 | 2 13 20 | 9.45758 | 28 | 10.54242 | 9.47622 | 31 | 10.52378 | 10.01864 | 2 | 9.98136 | 20 |
| 41 | 46 32 | 13 28 | 45801 | 29 | 54199 | 47668 | 32 | 52332 | 01868 | 3 | 98132 | 19 |
| 42 | 46 24 | 13 36 | 45843 | 30 | 54157 | 47714 | 32 | 52286 | 01871 | 3 | 98129 | 18 |
| 43 | 46 16 | 13 44 | 45885 | 30 | 54115 | 47760 | 33 | 52240 | 01875 | 3 | 98125 | 17 |
| 44 | 46 8 | 13 52 | 45927 | 31 | 54073 | 47806 | 34 | 52194 | 01879 | 3 | 98121 | 16 |
| 45 | 9 46 0 | 2 14 0 | 9.45969 | 32 | 10.54031 | 9.47852 | 35 | 10.52148 | 10.01883 | 3 | 9.98117 | 15 |
| 46 | 45 52 | 14 8 | 46011 | 33 | 53989 | 47897 | 36 | 52103 | 01887 | 3 | 98113 | 14 |
| 47 | 45 44 | 14 16 | 46053 | 33 | 53947 | 47943 | 36 | 52057 | 01890 | 3 | 98110 | 13 |
| 48 | 45 36 | 14 24 | 46095 | 34 | 53905 | 47989 | 37 | 52011 | 01894 | 3 | 98106 | 12 |
| 49 | 45 28 | 14 32 | 46136 | 35 | 53864 | 48035 | 38 | 51965 | 01898 | 3 | 98102 | 11 |
| 50 | 9 45 20 | 2 14 40 | 9.46178 | 36 | 10.53822 | 9.48080 | 39 | 10.51920 | 10.01902 | 3 | 9.98098 | 10 |
| 51 | 45 12 | 14 48 | 46220 | 36 | 53780 | 48126 | 39 | 51874 | 01906 | 3 | 98094 | 9 |
| 52 | 45 4 | 14 56 | 46262 | 37 | 53738 | 48171 | 40 | 51829 | 01910 | 3 | 98090 | 8 |
| 53 | 44 56 | 15 4 | 46303 | 38 | 53697 | 48217 | 41 | 51783 | 01913 | 3 | 98087 | 7 |
| 54 | 44 48 | 15 12 | 46345 | 38 | 53655 | 48262 | 42 | 51738 | 01917 | 3 | 98083 | 6 |
| 55 | 9 44 40 | 2 15 20 | 9.46386 | 39 | 10.53614 | 9.48307 | 43 | 10.51693 | 10.01921 | 3 | 9.98079 | 5 |
| 56 | 44 32 | 15 28 | 46428 | 40 | 53572 | 48353 | 43 | 51647 | 01925 | 3 | 98075 | 4 |
| 57 | 44 24 | 15 36 | 46469 | 41 | 53531 | 48398 | 44 | 51602 | 01929 | 4 | 98071 | 3 |
| 58 | 44 16 | 15 44 | 46511 | 41 | 53489 | 48443 | 45 | 51557 | 01933 | 4 | 98067 | 2 |
| 59 | 44 8 | 15 52 | 46552 | 42 | 53448 | 48489 | 46 | 51511 | 01937 | 4 | 98063 | 1 |
| 60 | 44 0 | 16 0 | 46594 | 43 | 53406 | 48534 | 46 | 51466 | 01940 | 4 | 98060 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 106° | | | A | | A | B | | B | C | | C | 73° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. A | 5 | 11 | 16 | 21 | 27 | 32 | 37 |
| B | 6 | 12 | 17 | 23 | 29 | 35 | 41 |
| C | 0 | 1 | 1 | 2 | 2 | 3 | 3 |

TABLE 44. [Page 625

Log. Sines, Tangents, and Secants.

| 17° | | | A | | A | B | | B | C | · | C | 162° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 9 44 0 | 2 16 0 | 9. 46594 | 0 | 10. 53406 | 9. 48534 | 0 | 10. 51466 | 10. 01940 | 0 | 9. 98060 | 60 |
| 1 | 43 52 | 16 8 | 46635 | 1 | 53365 | 48579 | 1 | 51421 | 01944 | 0 | 98056 | 59 |
| 2 | 43 44 | 16 16 | 46676 | 1 | 53324 | 48624 | 1 | 51376 | 01948 | 0 | 98052 | 58 |
| 3 | 43 36 | 16 24 | 46717 | 2 | 53283 | 48669 | 2 | 51331 | 01952 | 0 | 98048 | 57 |
| 4 | 43 28 | 16 32 | 46758 | 3 | 53242 | 48714 | 3 | 51286 | 01956 | 0 | 98044 | 56 |
| 5 | 9 43 20 | 2 16 40 | 9. 46800 | 3 | 10. 53200 | 9. 48759 | 4 | 10. 51241 | 10. 01960 | 0 | 9. 98040 | 55 |
| 6 | 43 12 | 16 48 | 46841 | 4 | 53159 | 48804 | 4 | 51196 | 01964 | 0 | 98036 | 54 |
| 7 | 43 4 | 16 56 | 46882 | 5 | 53118 | 48849 | 5 | 51151 | 01968 | 0 | 98032 | 53 |
| 8 | 42 56 | 17 4 | 46923 | 5 | 53077 | 48894 | 6 | 51106 | 01971 | 1 | 98029 | 52 |
| 9 | 42 48 | 17 12 | 46964 | 6 | 53036 | 48939 | 7 | 51061 | 01975 | 1 | 98025 | 51 |
| 10 | 9 42 40 | 2 17 20 | 9. 47005 | 7 | 10. 52995 | 9. 48984 | 7 | 10. 51016 | 10. 01979 | 1 | 9. 98021 | 50 |
| 11 | 42 32 | 17 28 | 47045 | 7 | 52955 | 49029 | 8 | 50971 | 01983 | 1 | 98017 | 49 |
| 12 | 42 24 | 17 36 | 47086 | 8 | 52914 | 49073 | 9 | 50927 | 01987 | 1 | 98013 | 48 |
| 13 | 42 16 | 17 44 | 47127 | 9 | 52873 | 49118 | 10 | 50882 | 01991 | 1 | 98009 | 47 |
| 14 | 42 8 | 17 52 | 47168 | 9 | 52832 | 49163 | 10 | 50837 | 01995 | 1 | 98005 | 46 |
| 15 | 9 42 0 | 2 18 0 | 9. 47209 | 10 | 10. 52791 | 9. 49207 | 11 | 10. 50793 | 10. 01999 | 1 | 9. 98001 | 45 |
| 16 | 41 52 | 18 8 | 47249 | 11 | 52751 | 49252 | 12 | 50748 | 02003 | 1 | 97997 | 44 |
| 17 | 41 44 | 18 16 | 47290 | 11 | 52710 | 49296 | 12 | 50704 | 02007 | 1 | 97993 | 43 |
| 18 | 41 36 | 18 24 | 47330 | 12 | 52670 | 49341 | 13 | 50659 | 02011 | 1 | 97989 | 42 |
| 19 | 41 28 | 18 32 | 47371 | 13 | 52629 | 49385 | 14 | 50615 | 02014 | 1 | 97986 | 41 |
| 20 | 9 41 20 | 2 18 40 | 9. 47411 | 13 | 10. 52589 | 9. 49430 | 15 | 10. 50570 | 10. 02018 | 1 | 9. 97982 | 40 |
| 21 | 41 12 | 18 48 | 47452 | 14 | 52548 | 49474 | 15 | 50526 | 02022 | 1 | 97978 | 39 |
| 22 | 41 4 | 18 56 | 47492 | 15 | 52508 | 49519 | 16 | 50481 | 02026 | 1 | 97974 | 38 |
| 23 | 40 56 | 19 4 | 47533 | 15 | 52467 | 49563 | 17 | 50437 | 02030 | 2 | 97970 | 37 |
| 24 | 40 48 | 19 12 | 47573 | 16 | 52427 | 49607 | 18 | 50393 | 02034 | 2 | 97966 | 36 |
| 25 | 9 40 40 | 2 19 20 | 9. 47613 | 17 | 10. 52387 | 9. 49652 | 18 | 10. 50348 | 10. 02038 | 2 | 9. 97962 | 35 |
| 26 | 40 32 | 19 28 | 47654 | 17 | 52346 | 49696 | 19 | 50304 | 02042 | 2 | 97958 | 34 |
| 27 | 40 24 | 19 36 | 47694 | 18 | 52306 | 49740 | 20 | 50260 | 02046 | 2 | 97954 | 33 |
| 28 | 40 16 | 19 44 | 47734 | 19 | 52266 | 49784 | 21 | 50216 | 02050 | 2 | 97950 | 32 |
| 29 | 40 8 | 19 52 | 47774 | 19 | 52226 | 49828 | 21 | 50172 | 02054 | 2 | 97946 | 31 |
| 30 | 9 40 0 | 2 20 0 | 9. 47814 | 20 | 10. 52186 | 9. 49872 | 22 | 10. 50128 | 10. 02058 | 2 | 9. 97942 | 30 |
| 31 | 39 52 | 20 8 | 47854 | 21 | 52146 | 49916 | 23 | 50084 | 02062 | 2 | 97938 | 29 |
| 32 | 39 44 | 20 16 | 47894 | 21 | 52106 | 49960 | 24 | 50040 | 02066 | 2 | 97934 | 28 |
| 33 | 39 36 | 20 24 | 47934 | 22 | 52066 | 50004 | 24 | 49996 | 02070 | 2 | 97930 | 27 |
| 34 | 39 28 | 20 32 | 47974 | 23 | 52026 | 50048 | 25 | 49952 | 02074 | 2 | 97926 | 26 |
| 35 | 9 39 20 | 2 20 40 | 9. 48014 | 23 | 10. 51986 | 9. 50092 | 26 | 10. 49908 | 10. 02078 | 2 | 9. 97922 | 25 |
| 36 | 39 12 | 20 48 | 48054 | 24 | 51946 | 50136 | 26 | 49864 | 02082 | 2 | 97918 | 24 |
| 37 | 39 4 | 20 56 | 48094 | 25 | 51906 | 50180 | 27 | 49820 | 02086 | 2 | 97914 | 23 |
| 38 | 38 56 | 21 4 | 48133 | 25 | 51867 | 50223 | 28 | 49777 | 02090 | 3 | 97910 | 22 |
| 39 | 38 48 | 21 12 | 48173 | 26 | 51827 | 50267 | 29 | 49733 | 02094 | 3 | 97906 | 21 |
| 40 | 9 38 40 | 2 21 20 | 9. 48213 | 27 | 10. 51787 | 9. 50311 | 29 | 10. 49689 | 10. 02098 | 3 | 9. 97902 | 20 |
| 41 | 38 32 | 21 28 | 48252 | 27 | 51748 | 50355 | 30 | 49645 | 02102 | 3 | 97898 | 19 |
| 42 | 38 24 | 21 36 | 48292 | 28 | 51708 | 50398 | 31 | 49602 | 02106 | 3 | 97894 | 18 |
| 43 | 38 16 | 21 44 | 48332 | 29 | 51668 | 50442 | 32 | 49558 | 02110 | 3 | 97890 | 17 |
| 44 | 38 8 | 21 52 | 48371 | 29 | 51629 | 50485 | 32 | 49515 | 02114 | 3 | 97886 | 16 |
| 45 | 9 38 0 | 2 22 0 | 9. 48411 | 30 | 10. 51589 | 9. 50529 | 33 | 10. 49471 | 10. 02118 | 3 | 9. 97882 | 15 |
| 46 | 37 52 | 22 8 | 48450 | 31 | 51550 | 50572 | 34 | 49428 | 02122 | 3 | 97878 | 14 |
| 47 | 37 44 | 22 16 | 48490 | 31 | 51510 | 50616 | 35 | 49384 | 02126 | 3 | 97874 | 13 |
| 48 | 37 36 | 22 24 | 48529 | 32 | 51471 | 50659 | 35 | 49341 | 02130 | 3 | 97870 | 12 |
| 49 | 37 28 | 22 32 | 48568 | 33 | 51432 | 50703 | 36 | 49297 | 02134 | 3 | 97866 | 11 |
| 50 | 9 37 20 | 2 22 40 | 9. 48607 | 33 | 10. 51393 | 9. 50746 | 37 | 10. 49254 | 10. 02139 | 3 | 9. 97861 | 10 |
| 51 | 37 12 | 22 48 | 48647 | 34 | 51353 | 50789 | 37 | 49211 | 02143 | 3 | 97857 | 9 |
| 52 | 37 4 | 22 56 | 48686 | 35 | 51314 | 50833 | 38 | 49167 | 02147 | 3 | 97853 | 8 |
| 53 | 36 56 | 23 4 | 48725 | 35 | 51275 | 50876 | 39 | 49124 | 02151 | 4 | 97849 | 7 |
| 54 | 36 48 | 23 12 | 48764 | 36 | 51236 | 50919 | 40 | 49081 | 02155 | 4 | 97845 | 6 |
| 55 | 9 36 40 | 2 23 20 | 9. 48803 | 37 | 10. 51197 | 9. 50962 | 40 | 10. 49038 | 10. 02159 | 4 | 9. 97841 | 5 |
| 56 | 36 32 | 23 28 | 48842 | 37 | 51158 | 51005 | 41 | 48995 | 02163 | 4 | 97837 | 4 |
| 57 | 36 24 | 23 36 | 48881 | 38 | 51119 | 51048 | 42 | 48952 | 02167 | 4 | 97833 | 3 |
| 58 | 36 16 | 23 44 | 48920 | 39 | 51080 | 51092 | 43 | 48908 | 02171 | 4 | 97829 | 2 |
| 59 | 36 8 | 23 52 | 48959 | 39 | 51041 | 51135 | 43 | 48865 | 02175 | 4 | 97825 | 1 |
| 60 | 36 0 | 24 0 | 48998 | 40 | 51002 | 51178 | 44 | 48822 | 02179 | 4 | 97821 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 107° | | | A | | A | B | | B | C | | C | 72° |

| Seconds of time ....... | 1s | 2s | 3s | 4s | 5s | 6s | 7s |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A B C | 5 6 0 | 10 11 1 | 15 17 1 | 20 22 2 | 25 28 2 | 30 33 3 | 35 39 3 |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

| 18° | | | A | | A | B | | B | C | | C | 161° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 9 36 0 | 2 24 0 | 9.48998 | 0 | 10.51002 | 9.51178 | 0 | 10.48822 | 10.02179 | 0 | 9.97821 | 60 |
| 1 | 35 52 | 24 8 | 49037 | 1 | 50963 | 51221 | 1 | 48779 | 02183 | 0 | 97817 | 59 |
| 2 | 35 44 | 24 16 | 49076 | 1 | 50924 | 51264 | 1 | 48736 | 02188 | 0 | 97812 | 58 |
| 3 | 35 36 | 24 24 | 49115 | 2 | 50885 | 51306 | 2 | 48694 | 02192 | 0 | 97808 | 57 |
| 4 | 35 28 | 24 32 | 49153 | 3 | 50847 | 51349 | 3 | 48651 | 02196 | 0 | 97804 | 56 |
| 5 | 9 35 20 | 2 24 40 | 9.49192 | 3 | 10.50808 | 9.51392 | 3 | 10.48608 | 10.02200 | 0 | 9.97800 | 55 |
| 6 | 35 12 | 24 48 | 49231 | 4 | 50769 | 51435 | 4 | 48565 | 02204 | 0 | 97796 | 54 |
| 7 | 35 4 | 24 56 | 49269 | 4 | 50731 | 51478 | 5 | 48522 | 02208 | 0 | 97792 | 53 |
| 8 | 34 56 | 25 4 | 49308 | 5 | 50692 | 51520 | 6 | 48480 | 02212 | 1 | 97788 | 52 |
| 9 | 34 48 | 25 12 | 49347 | 6 | 50653 | 51563 | 6 | 48437 | 02216 | 1 | 97784 | 51 |
| 10 | 9 34 40 | 2 25 20 | 9.49385 | 6 | 10.50615 | 9.51606 | 7 | 10.48394 | 10.02221 | 1 | 9.97779 | 50 |
| 11 | 34 32 | 25 28 | 49424 | 7 | 50576 | 51648 | 8 | 48352 | 02225 | 1 | 97775 | 49 |
| 12 | 34 24 | 25 36 | 49462 | 8 | 50538 | 51691 | 8 | 48309 | 02229 | 1 | 97771 | 48 |
| 13 | 34 16 | 25 44 | 49500 | 8 | 50500 | 51734 | 9 | 48266 | 02233 | 1 | 97767 | 47 |
| 14 | 34 8 | 25 52 | 49539 | 9 | 50461 | 51776 | 10 | 48224 | 02237 | 1 | 97763 | 46 |
| 15 | 9 34 0 | 2 26 0 | 9.49577 | 9 | 10.50423 | 9.51819 | 10 | 10.48181 | 10.02241 | 1 | 9.97759 | 45 |
| 16 | 33 52 | 26 8 | 49615 | ·10 | 50385 | 51861 | 11 | 48139 | 02246 | 1 | 97754 | 44 |
| 17 | 33 44 | 26 16 | 49654 | 11 | 50346 | 51903 | 12 | 48097 | 02250 | 1 | 97750 | 43 |
| 18 | 33 36 | 26 24 | 49692 | 11 | 50308 | 51946 | 13 | 48054 | 02254 | 1 | 97746 | 42 |
| 19 | 33 28 | 26 32 | 49730 | 12 | 50270 | 51988 | 13 | 48012 | 02258 | 1 | 97742 | 41 |
| 20 | 9 33 20 | 2 26 40 | 9.49768 | 13 | 10.50232 | 9.52031 | 14 | 10.47969 | 10.02262 | 1 | 9.97738 | 40 |
| 21 | 33 12 | 26 48 | 49806 | 13 | 50194 | 52073 | 15 | 47927 | 02266 | 1 | 97734 | 39 |
| 22 | 33 4 | 26 56 | 49844 | 14 | 50156 | 52115 | 15 | 47885 | 02271 | 2 | 97729 | 38 |
| 23 | 32 56 | 27 4 | 49882 | 14 | 50118 | 52157 | 16 | 47843 | 02275 | 2 | 97725 | 37 |
| 24 | 32 48 | 27 12 | 49920 | 15 | 50080 | 52200 | 17 | 47800 | 02279 | 2 | 97721 | 36 |
| 25 | 9 32 40 | 2 27 20 | 9.49958 | 16 | 10.50042 | 9.52242 | 17 | 10.47758 | 10.02283 | 2 | 9.97717 | 35 |
| 26 | 32 32 | 27 28 | 49996 | 16 | 50004 | 52284 | 18 | 47716 | 02287 | 2 | 97713 | 34 |
| 27 | 32 24 | 27 36 | 50034 | 17 | 49966 | 52326 | 19 | 47674 | 02292 | 2 | 97708 | 33 |
| 28 | 32 16 | 27 44 | 50072 | 18 | 49928 | 52368 | 20 | 47632 | 02296 | 2 | 97704 | 32 |
| 29 | 32 8 | 27 52 | 50110 | 18 | 49890 | 52410 | 20 | 47590 | 02300 | 2 | 97700 | 31 |
| 30 | 9 32 0 | 2 28 0 | 9.50148 | 19 | 10.49852 | 9.52452 | 21 | 10.47548 | 10.02304 | 2 | 9.97696 | 30 |
| 31 | 31 52 | 28 8 | 50185 | 20 | 49815 | 52494 | 22 | 47506 | 02309 | 2 | 97691 | 29 |
| 32 | 31 44 | 28 16 | 50223 | 20 | 49777 | 52536 | 22 | 47464 | 02313 | 2 | 97687 | 28 |
| 33 | 31 36 | 28 24 | 50261 | 21 | 49739 | 52578 | 23 | 47422 | 02317 | 2 | 97683 | 27 |
| 34 | 31 28 | 28 32 | 50298 | 21 | 49702 | 52620 | 24 | 47380 | 02321 | 2 | 97679 | 26 |
| 35 | 9 31 20 | 2 28 40 | 9.50336 | 22 | 10.49664 | 9.52661 | 24 | 10.47339 | 10.02326 | 2 | 9.97674 | 25 |
| 36 | 31 12 | 28 48 | 50374 | 23 | 49626 | 52703 | 25 | 47297 | 02330 | 3 | 97670 | 24 |
| 37 | 31 4 | 28 56 | 50411 | 23 | 49589 | 52745 | 26 | 47255 | 02334 | 3 | 97666 | 23 |
| 38 | 30 56 | 29 4 | 50449 | 24 | 49551 | 52787 | 27 | 47213 | 02338 | 3 | 97662 | 22 |
| 39 | 30 48 | 29 12 | 50486 | 25 | 49514 | 52829 | 27 | 47171 | 02343 | 3 | 97657 | 21 |
| 40 | 9 30 40 | 2 29 20 | 9.50523 | 25 | 10.49477 | 9.52870 | 28 | 10.47130 | 10.02347 | 3 | 9.97653 | 20 |
| 41 | 30 32 | 29 28 | 50561 | 26 | 49439 | 52912 | 29 | 47088 | 02351 | 3 | 97649 | 19 |
| 42 | 30 24 | 29 36 | 50598 | 26 | 49402 | 52953 | 29 | 47047 | 02355 | 3 | 97645 | 18 |
| 43 | 30 16 | 29 44 | 50635 | 27 | 49365 | 52995 | 30 | 47005 | 02360 | 3 | 97640 | 17 |
| 44 | 30 8 | 29 52 | 50673 | 28 | 49327 | 53037 | 31 | 46963 | 02364 | 3 | 97636 | 16 |
| 45 | 9 30 0 | 2 30 0 | 9.50710 | 28 | 10.49290 | 9.53078 | 31 | 10.46922 | 10.02368 | 3 | 9.97632 | 15 |
| 46 | 29 52 | 30 8 | 50747 | 29 | 49253 | 53120 | 32 | 46880 | 02372 | 3 | 97628 | 14 |
| 47 | 29 44 | 30 16 | 50784 | 30 | 49216 | 53161 | 33 | 46839 | 02377 | 3 | 97623 | 13 |
| 48 | 29 36 | 30 24 | 50821 | 30 | 49179 | 53202 | 34 | 46798 | 02381 | 3 | 97619 | 12 |
| 49 | 29 28 | 30 32 | .50858 | 31 | 49142 | 53244 | 34 | 46756 | 02385 | 3 | 97615 | 11 |
| 50 | 9 29 20 | 2 30 40 | 9.50896 | 31 | 10.49104 | 9.53285 | 35 | 10.46715 | 10.02390 | 4 | 9.97610 | 10 |
| 51 | 29 12 | 30 48 | 50933 | 32 | 49067 | 53327 | 36 | 46673 | 02394 | 4 | 97606 | 9 |
| 52 | 29 4 | 30 56 | 50970 | 33 | 49030 | 53368 | 36 | 46632 | 02398 | 4 | 97602 | 8 |
| 53 | 28 56 | 31 4 | 5?007 | 33 | 48993 | 53409 | 37 | 46591 | 02403 | 4 | 97597 | 7 |
| 54 | 28 48 | 31 12 | 51043 | 34 | 48957 | 53450 | 38 | 46550 | 02407 | 4 | 97593 | 6 |
| 55 | 9 28 40 | 2 31 20 | 9.51080 | 35 | 10.48920 | 9.53492 | 38 | 10.46508 | 10.02411 | 4 | 9.97589 | 5 |
| 56 | 28 32 | 31 28 | 51117 | 35 | 48883 | 53533 | 39 | 46467 | 02416 | 4 | 97584 | 4 |
| 57 | 28 24 | 31 36 | 51154 | 36 | 48846 | 53574 | 40 | 46426 | 02420 | 4 | 97580 | 3 |
| 58 | 28 16 | 31 44 | 51191 | 37 | 48809 | 53615 | 41 | 46385 | 02424 | 4 | 97576 | 2 |
| 59 | 28 8 | 31 52 | 51227 | 37 | 48773 | 53656 | 41 | 46344 | 02429 | 4 | 97571 | 1 |
| 60 | 28 0 | 32 0 | 51264 | 38 | 48736 | 53697 | 42 | 46303 | 02433 | 4 | 97567 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 108° | | | A | | A | B | | B | C | | C | 71° |

| Seconds of time ....... | 1s | 2s | 3s | 4s | 5s | 6s | 7s |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 5 | 9 | 14 | 19 | 24 | 28 | 33 |
| B | 5 | 10 | 16 | 21 | 26 | 31 | 37 |
| C | 1 | 1 | 2 | 2 | 3 | 3 | 4 |

## TABLE 44.                                   [Page 627

Log. Sines, Tangents, and Secants.

**19°** | A | A | B | B | C | C | **160°**

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 9 28 0 | 2 32 0 | 9. 51264 | 0 | 10. 48736 | 9. 53697 | 0 | 10. 46303 | 10. 02433 | 0 | 9. 97567 | 60 |
| 1 | 27 52 | 32 8 | 51301 | 1 | 48699 | 53738 | 1 | 46262 | 02437 | 0 | 97563 | 59 |
| 2 | 27 44 | 32 16 | 51338 | 1 | 48662 | 53779 | 1 | 46221 | 02442 | 0 | 97558 | 58 |
| 3 | 27 36 | 32 24 | 51374 | 2 | 48626 | 53820 | 2 | 46180 | 02446 | 0 | 97554 | 57 |
| 4 | 27 28 | 32 32 | 51411 | 2 | 48589 | 53861 | 3 | 46139 | 02450 | 0 | 97550 | 56 |
| 5 | 9 27 20 | 2 32 40 | 9. 51447 | 3 | 10. 48553 | 9. 53902 | 3 | 10. 46098 | 10. 02455 | 0 | 9. 97545 | 55 |
| 6 | 27 12 | 32 48 | 51484 | 4 | 48516 | 53943 | 4 | 46057 | 02459 | 0 | 97541 | 54 |
| 7 | 27 4 | 32 56 | 51520 | 4 | 48480 | 53984 | 5 | 46016 | 02464 | 1 | 97536 | 53 |
| 8 | 26 56 | 33 4 | 51557 | 5 | 48443 | 54025 | 5 | 45975 | 02468 | 1 | 97532 | 52 |
| 9 | 26 48 | 33 12 | 51593 | 5 | 48407 | 54065 | 6 | 45935 | 02472 | 1 | 97528 | 51 |
| 10 | 9 26 40 | 2 33 20 | 9. 51629 | 6 | 10. 48371 | 9. 54106 | 7 | 10. 45894 | 10. 02477 | 1 | 9. 97523 | 50 |
| 11 | 26 32 | 33 28 | 51666 | 7 | 48334 | 54147 | 7 | 45853 | 02481 | 1 | 97519 | 49 |
| 12 | 26 24 | 33 36 | 51702 | 7 | 48298 | 54187 | 8 | 45813 | 02485 | 1 | 97515 | 48 |
| 13 | 26 16 | 33 44 | 51738 | 8 | 48262 | 54228 | 9 | 45772 | 02490 | 1 | 97510 | 47 |
| 14 | 26 8 | 33 52 | 51774 | 8 | 48226 | 54269 | 9 | 45731 | 02494 | 1 | 97506 | 46 |
| 15 | 9 26 0 | 2 34 0 | 9. 51811 | 9 | 10. 48189 | 9. 54309 | 10 | 10. 45691 | 10. 02499 | 1 | 9. 97501 | 45 |
| 16 | 25 52 | 34 8 | 51847 | 10 | 48153 | 54350 | 11 | 45650 | 02503 | 1 | 97497 | 44 |
| 17 | 25 44 | 34 16 | 51883 | 10 | 48117 | 54390 | 11 | 45610 | 02508 | 1 | 97492 | 43 |
| 18 | 25 36 | 34 24 | 51919 | 11 | 48081 | 54431 | 12 | 45569 | 02512 | 1 | 97488 | 42 |
| 19 | 25 28 | 34 32 | 51955 | 11 | 48045 | 54471 | 13 | 45529 | 02516 | 1 | 97484 | 41 |
| 20 | 9 25 20 | 2 34 40 | 9. 51991 | 12 | 10. 48009 | 9. 54512 | 13 | 10. 45488 | 10. 02521 | 1 | 9. 97479 | 40 |
| 21 | 25 12 | 34 48 | 52027 | 12 | 47973 | 54552 | 14 | 45448 | 02525 | 2 | 97475 | 39 |
| 22 | 25 4 | 34 56 | 52063 | 13 | 47937 | 54593 | 15 | 45407 | 02530 | 2 | 97470 | 38 |
| 23 | 24 56 | 35 4 | 52099 | 14 | 47901 | 54633 | 15 | 45367 | 02534 | 2 | 97466 | 37 |
| 24 | 24 48 | 35 12 | 52135 | 14 | 47865 | 54673 | 16 | 45327 | 02539 | 2 | 97461 | 36 |
| 25 | 9 24 40 | 2 35 20 | 9. 52171 | 15 | 10. 47829 | 9. 54714 | 17 | 10. 45286 | 10. 02543 | 2 | 9. 97457 | 35 |
| 26 | 24 32 | 35 28 | 52207 | 15 | 47793 | 54754 | 17 | 45246 | 02547 | 2 | 97453 | 34 |
| 27 | 24 24 | 35 36 | 52242 | 16 | 47758 | 54794 | 18 | 45206 | 02552 | 2 | 97448 | 33 |
| 28 | 24 16 | 35 44 | 52278 | 17 | 47722 | 54835 | 19 | 45165 | 02556 | 2 | 97444 | 32 |
| 29 | 24 8 | 35 52 | 52314 | 17 | 47686 | 54875 | 19 | 45125 | 02561 | 2 | 97439 | 31 |
| 30 | 9 24 0 | 2 36 0 | 9. 52350 | 18 | 10. 47650 | 9. 54915 | 20 | 10. 45085 | 10. 02565 | 2 | 9. 97435 | 30 |
| 31 | 23 52 | 36 8 | 52385 | 18 | 47615 | 54955 | 21 | 45045 | 02570 | 2 | 97430 | 29 |
| 32 | 23 44 | 36 16 | 52421 | 19 | 47579 | 54995 | 21 | 45005 | 02574 | 2 | 97426 | 28 |
| 33 | 23 36 | 36 24 | 52456 | 20 | 47544 | 55035 | 22 | 44965 | 02579 | 2 | 97421 | 27 |
| 34 | 23 28 | 36 32 | 52492 | 20 | 47508 | 55075 | 23 | 44925 | 02583 | 3 | 97417 | 26 |
| 35 | 9 23 20 | 2 36 40 | 9. 52527 | 21 | 10. 47473 | 9. 55115 | 23 | 10. 44885 | 10. 02588 | 3 | 9. 97412 | 25 |
| 36 | 23 12 | 36 48 | 52563 | 21 | 47437 | 55155 | 24 | 44845 | 02592 | 3 | 97408 | 24 |
| 37 | 23 4 | 36 56 | 52598 | 22 | 47402 | 55195 | 25 | 44805 | 02597 | 3 | 97403 | 23 |
| 38 | 22 56 | 37 4 | 52634 | 22 | 47366 | 55235 | 25 | 44765 | 02601 | 3 | 97399 | 22 |
| 39 | 22 48 | 37 12 | 52669 | 23 | 47331 | 55275 | 26 | 44725 | 02606 | 3 | 97394 | 21 |
| 40 | 9 22 40 | 2 37 20 | 9. 52705 | 24 | 10. 47295 | 9. 55315 | 27 | 10. 44685 | 10. 02610 | 3 | 9. 97390 | 20 |
| 41 | 22 32 | 37 28 | 52740 | 24 | 47260 | 55355 | 27 | 44645 | 02615 | 3 | 97385 | 19 |
| 42 | 22 24 | 37 36 | 52775 | 25 | 47225 | 55395 | 28 | 44605 | 02619 | 3 | 97381 | 18 |
| 43 | 22 16 | 37 44 | 52811 | 26 | 47189 | 55434 | 29 | 44566 | 02624 | 3 | 97376 | 17 |
| 44 | 22 8 | 37 52 | 52846 | 26 | 47154 | 55474 | 29 | 44526 | 02628 | 3 | 97372 | 16 |
| 45 | 9 22 0 | 2 38 0 | 9. 52881 | 27 | 10. 47119 | 9. 55514 | 30 | 10. 44486 | 10. 02633 | 3 | 9. 97367 | 15 |
| 46 | 21 52 | 38 8 | 52916 | 27 | 47084 | 55554 | 31 | 44446 | 02637 | 3 | 97363 | 14 |
| 47 | 21 44 | 38 16 | 52951 | 28 | 47049 | 55593 | 31 | 44407 | 02642 | 3 | 97358 | 13 |
| 48 | 21 36 | 38 24 | 52986 | 29 | 47014 | 55633 | 32 | 44367 | 02647 | 4 | 97353 | 12 |
| 49 | 21 28 | 38 32 | 53021 | 29 | 46979 | 55673 | 33 | 44327 | 02651 | 4 | 97349 | 11 |
| 50 | 9 21 20 | 2 38 40 | 9. 53056 | 30 | 10. 46944 | 9. 55712 | 33 | 10. 44288 | 10. 02656 | 4 | 9. 97344 | 10 |
| 51 | 21 12 | 38 48 | 53092 | 30 | 46908 | 55752 | 34 | 44248 | 02660 | 4 | 97340 | 9 |
| 52 | 21 4 | 38 56 | 53126 | 31 | 46874 | 55791 | 35 | 44209 | 02665 | 4 | 97335 | 8 |
| 53 | 20 56 | 39 4 | 53161 | 32 | 46839 | 55831 | 35 | 44169 | 02669 | 4 | 97331 | 7 |
| 54 | 20 48 | 39 12 | 53196 | 32 | 46804 | 55870 | 36 | 44130 | 02674 | 4 | 97326 | 6 |
| 55 | 9 20 40 | 2 39 20 | 9. 53231 | 33 | 10. 46769 | 9. 55910 | 37 | 10. 44090 | 10. 02678 | 4 | 9. 97322 | 5 |
| 56 | 20 32 | 39 28 | 53266 | 33 | 46734 | 55949 | 37 | 44051 | 02683 | 4 | 97317 | 4 |
| 57 | 20 24 | 39 36 | 53301 | 34 | 46699 | 55989 | 38 | 44011 | 02688 | 4 | 97312 | 3 |
| 58 | 20 16 | 39 44 | 53336 | 34 | 46664 | 56028 | 39 | 43972 | 02692 | 4 | 97308 | 2 |
| 59 | 20 8 | 39 52 | 53370 | 35 | 46630 | 56067 | 39 | 43933 | 02697 | 4 | 97303 | 1 |
| 60 | 20 0 | 40 0 | 53405 | 36 | 46595 | 56107 | 40 | 43893 | 02701 | 4 | 97299 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

**109°** | A | A | B | B | C | C | **70°**

| Seconds of time........ | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 4 | 9 | 13 | 18 | 22 | 27 | 31 |
| B | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
| C | 1 | 1 | 2 | 2 | 3 | 3 | 4 |

## TABLE 44.

### Log. Sines, Tangents, and Secants.

| 20° | A | A | B | C | C | 159° |
|---|---|---|---|---|---|---|

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 9 20 0 | 2 40 0 | 9.53405 | 0 | 10.46595 | 9.56107 | 0 | 10.43893 | 10.02701 | 0 | 9.97299 | 60 |
| 1 | 19 52 | 40 8 | 53440 | 1 | 46560 | 56146 | 1 | 43854 | 02706 | 0 | 97294 | 59 |
| 2 | 19 44 | 40 16 | 53475 | 1 | 46525 | 56185 | 1 | 43815 | 02711 | 0 | 97289 | 58 |
| 3 | 19 36 | 40 24 | 53509 | 2 | 46491 | 56224 | 2 | 43776 | 02715 | 0 | 97285 | 57 |
| 4 | 19 28 | 40 32 | 53544 | 2 | 46456 | 56264 | 3 | 43736 | 02720 | 0 | 97280 | 56 |
| 5 | 9 19 20 | 2 40 40 | 9.53578 | 3 | 10.46422 | 9.56303 | 3 | 10.43697 | 10.02724 | 0 | 9.97276 | 55 |
| 6 | 19 12 | 40 48 | 53613 | 3 | 46387 | 56342 | 4 | 43658 | 02729 | 0 | 97271 | 54 |
| 7 | 19 4 | 40 56 | 53647 | 4 | 46353 | 56381 | 4 | 43619 | 02734 | 1 | 97266 | 53 |
| 8 | 18 56 | 41 4 | 53682 | 5 | 46318 | 56420 | 5 | 43580 | 02738 | 1 | 97262 | 52 |
| 9 | 18 48 | 41 12 | 53716 | 5 | 46284 | 56459 | 6 | 43541 | 02743 | 1 | 97257 | 51 |
| 10 | 9 18 40 | 2 41 20 | 9.53751 | 6 | 10.46249 | 9.56498 | 6 | 10.43502 | 10.02748 | 1 | 9.97252 | 50 |
| 11 | 18 32 | 41 28 | 53785 | 6 | 46215 | 56537 | 7 | 43463 | 02752 | 1 | 97248 | 49 |
| 12 | 18 24 | 41 36 | 53819 | 7 | 46181 | 56576 | 8 | 43424 | 02757 | 1 | 97243 | 48 |
| 13 | 18 16 | 41 44 | 53854 | 7 | 46146 | 56615 | 8 | 43385 | 02762 | 1 | 97238 | 47 |
| 14 | 18 8 | 41 52 | 53888 | 8 | 46112 | 56654 | 9 | 43346 | 02766 | 1 | 97234 | 46 |
| 15 | 9 18 0 | 2 42 0 | 9.53922 | 8 | 10.46078 | 9.56693 | 10 | 10.43307 | 10.02771 | 1 | 9.97229 | 45 |
| 16 | 17 52 | 42 8 | 53957 | 9 | 46043 | 56732 | 10 | 43268 | 02776 | 1 | 97224 | 44 |
| 17 | 17 44 | 42 16 | 53991 | 10 | 46009 | 56771 | 11 | 43229 | 02780 | 1 | 97220 | 43 |
| 18 | 17 36 | 42 24 | 54025 | 10 | 45975 | 56810 | 12 | 43190 | 02785 | 1 | 97215 | 42 |
| 19 | 17 28 | 42 32 | 54059 | 11 | 45941 | 56849 | 12 | 43151 | 02790 | 1 | 97210 | 41 |
| 20 | 9 17 20 | 2 42 40 | 9.54093 | 11 | 10.45907 | 9.56887 | 13 | 10.43113 | 10.02794 | 2 | 9.97206 | 40 |
| 21 | 17 12 | 42 48 | 54127 | 12 | 45873 | 56926 | 13 | 43074 | 02799 | 2 | 97201 | 39 |
| 22 | 17 4 | 42 56 | 54161 | 12 | 45839 | 56965 | 14 | 43035 | 02804 | 2 | 97196 | 38 |
| 23 | 16 56 | 43 4 | 54195 | 13 | 45805 | 57004 | 15 | 42996 | 02808 | 2 | 97192 | 37 |
| 24 | 16 48 | 43 12 | 54229 | 14 | 45771 | 57042 | 15 | 42958 | 02813 | 2 | 97187 | 36 |
| 25 | 9 16 40 | 2 43 20 | 9.54263 | 14 | 10.45737 | 9.57081 | 16 | 10.42919 | 10.02818 | 2 | 9.97182 | 35 |
| 26 | 16 32 | 43 28 | 54297 | 15 | 45703 | 57120 | 17 | 42880 | 02822 | 2 | 97178 | 34 |
| 27 | 16 24 | 43 36 | 54331 | 15 | 45669 | 57158 | 17 | 42842 | 02827 | 2 | 97173 | 33 |
| 28 | 16 16 | 43 44 | 54365 | 16 | 45635 | 57197 | 18 | 42803 | 02832 | 2 | 97168 | 32 |
| 29 | 16 8 | 43 52 | 54399 | 16 | 45601 | 57235 | 19 | 42765 | 02837 | 2 | 97163 | 31 |
| 30 | 9 16 0 | 2 44 0 | 9.54433 | 17 | 10.45567 | 9.57274 | 19 | 10.42726 | 10.02841 | 2 | 9.97159 | 30 |
| 31 | 15 52 | 44 8 | 54466 | 17 | 45534 | 57312 | 20 | 42688 | 02846 | 2 | 97154 | 29 |
| 32 | 15 44 | 44 16 | 54500 | 18 | 45500 | 57351 | 21 | 42649 | 02851 | 3 | 97149 | 28 |
| 33 | 15 36 | 44 24 | 54534 | 19 | 45466 | 57389 | 21 | 42611 | 02855 | 3 | 97145 | 27 |
| 34 | 15 28 | 44 32 | 54567 | 19 | 45433 | 57428 | 22 | 42572 | 02860 | 3 | 97140 | 26 |
| 35 | 9 15 20 | 2 44 40 | 9.54601 | 20 | 10.45399 | 9.57466 | 22 | 10.42534 | 10.02865 | 3 | 9.97135 | 25 |
| 36 | 15 12 | 44 48 | 54635 | 20 | 45365 | 57504 | 23 | 42496 | 02870 | 3 | 97130 | 24 |
| 37 | 15 4 | 44 56 | 54668 | 21 | 45332 | 57543 | 24 | 42457 | 02874 | 3 | 97126 | 23 |
| 38 | 14 56 | 45 4 | 54702 | 21 | 45298 | 57581 | 24 | 42419 | 02879 | 3 | 97121 | 22 |
| 39 | 14 48 | 45 12 | 54735 | 22 | 45265 | 57619 | 25 | 42381 | 02884 | 3 | 97116 | 21 |
| 40 | 9 14 40 | 2 45 20 | 9.54769 | 23 | 10.45231 | 9.57658 | 26 | 10.42342 | 10.02889 | 3 | 9.97111 | 20 |
| 41 | 14 32 | 45 28 | 54802 | 23 | 45198 | 57696 | 26 | 42304 | 02893 | 3 | 97107 | 19 |
| 42 | 14 24 | 45 36 | 54836 | 24 | 45164 | 57734 | 27 | 42266 | 02898 | 3 | 97102 | 18 |
| 43 | 14 16 | 45 44 | 54869 | 24 | 45131 | 57772 | 28 | 42228 | 02903 | 3 | 97097 | 17 |
| 44 | 14 8 | 45 52 | 54903 | 25 | 45097 | 57810 | 28 | 42190 | 02908 | 3 | 97092 | 16 |
| 45 | 9 14 0 | 2 46 0 | 9.54936 | 25 | 10.45064 | 9.57849 | 29 | 10.42151 | 10.02913 | 4 | 9.97087 | 15 |
| 46 | 13 52 | 46 8 | 54969 | 26 | 45031 | 57887 | 30 | 42113 | 02917 | 4 | 97083 | 14 |
| 47 | 13 44 | 46 16 | 55003 | 26 | 44997 | 57925 | 30 | 42075 | 02922 | 4 | 97078 | 13 |
| 48 | 13 36 | 46 24 | 55036 | 27 | 44964 | 57963 | 31 | 42037 | 02927 | 4 | 97073 | 12 |
| 49 | 13 28 | 46 32 | 55069 | 28 | 44931 | 58001 | 31 | 41999 | 02932 | 4 | 97068 | 11 |
| 50 | 9 13 20 | 2 46 40 | 9.55102 | 28 | 10.44898 | 9.58039 | 32 | 10.41961 | 10.02937 | 4 | 9.97063 | 10 |
| 51 | 13 12 | 46 48 | 55136 | 29 | 44864 | 58077 | 33 | 41923 | 02941 | 4 | 97059 | 9 |
| 52 | 13 4 | 46 56 | 55169 | 29 | 44831 | 58115 | 33 | 41885 | 02946 | 4 | 97054 | 8 |
| 53 | 12 56 | 47 4 | 55202 | 30 | 44798 | 58153 | 34 | 41847 | 02951 | 4 | 97049 | 7 |
| 54 | 12 48 | 47 12 | 55235 | 30 | 44765 | 58191 | 35 | 41809 | 02956 | 4 | 97044 | 6 |
| 55 | 9 12 40 | 2 47 20 | 9.55268 | 31 | 10.44732 | 9.58229 | 35 | 10.41771 | 10.02961 | 4 | 9.97039 | 5 |
| 56 | 12 32 | 47 28 | 55301 | 32 | 44699 | 58267 | 36 | 41733 | 02965 | 4 | 97035 | 4 |
| 57 | 12 24 | 47 36 | 55334 | 32 | 44666 | 58304 | 37 | 41696 | 02970 | 4 | 97030 | 3 |
| 58 | 12 16 | 47·44 | 55367 | 33 | 44633 | 58342 | 37 | 41658 | 02975 | 5 | 97025 | 2 |
| 59 | 12 8 | 47 52 | 55400 | 33 | 44600 | 58380 | 38 | 41620 | 02980 | 5 | 97020 | 1 |
| 60 | 12 0 | 48 0 | 55433 | 34 | 44567 | 58418 | 39 | 41582 | 02985 | 5 | 97015 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| 110° | A | A | B | B | C | C | 69° |
|---|---|---|---|---|---|---|---|

| Seconds of time....... | 1s | 2s | 3s | 4s | 5s | 6s | 7s |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 4 | 8 | 13 | 17 | 21 | 25 | 30 |
| B | 5 | 10 | 14 | 19 | 24 | 29 | 34 |
| C | 1 | 1 | 2 | 2 | 3 | 4 | 4 |

TABLE 44.  [Page 629

Log. Sines, Tangents, and Secants.

21°                                A            A          B              B           C              C           158°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 9 12 0 | 2 48 0 | 9.55433 | 0 | 10.44567 | 9.58418 | 0 | 10.41582 | 10.02985 | 0 | 9.97015 | 60 |
| 1 | 11 52 | 48 8 | 55466 | 1 | 44534 | 58455 | 1 | 41545 | 02990 | 0 | 97010 | 59 |
| 2 | 11 44 | 48 16 | 55499 | 1 | 44501 | 58493 | 1 | 41507 | 02995 | 0 | 97005 | 58 |
| 3 | 11 36 | 48 24 | 55532 | 2 | 44468 | 58531 | 2 | 41469 | 02999 | 0 | 97001 | 57 |
| 4 | 11 28 | 48 32 | 55564 | 2 | 44436 | 58569 | 2 | 41431 | 03004 | 0 | 96996 | 56 |
| 5 | 9 11 20 | 2 48 40 | 9.55597 | 3 | 10.44403 | 9.58606 | 3 | 10.41394 | 10.03009 | 0 | 9.96991 | 55 |
| 6 | 11 12 | 48 48 | 55630 | 3 | 44370 | 58644 | 4 | 41356 | 03014 | 0 | 96986 | 54 |
| 7 | 11 4 | 48 56 | 55663 | 4 | 44337 | 58681 | 4 | 41319 | 03019 | 1 | 96981 | 53 |
| 8 | 10 56 | 49 4 | 55695 | 4 | 44305 | 58719 | 5 | 41281 | 03024 | 1 | 96976 | 52 |
| 9 | 10 48 | 49 12 | 55728 | 5 | 44272 | 58757 | 6 | 41243 | 03029 | 1 | 96971 | 51 |
| 10 | 9 10 40 | 2 49 20 | 9.55761 | 5 | 10.44239 | 9.58794 | 6 | 10.41206 | 10.03034 | 1 | 9.96966 | 50 |
| 11 | 10 32 | 49 28 | 55793 | 6 | 44207 | 58832 | 7 | 41168 | 03038 | 1 | 96962 | 49 |
| 12 | 10 24 | 49 36 | 55826 | 6 | 44174 | 58869 | 7 | 41131 | 03043 | 1 | 96957 | 48 |
| 13 | 10 16 | 49 44 | 55858 | 7 | 44142 | 58907 | 8 | 41093 | 03048 | 1 | 96952 | 47 |
| 14 | 10 8 | 49 52 | 55891 | 7 | 44109 | 58944 | 9 | 41056 | 03053 | 1 | 96947 | 46 |
| 15 | 9 10 0 | 2 50 0 | 9.55923 | 8 | 10.44077 | 9.58981 | 9 | 10.41019 | 10.03058 | 1 | 9.96942 | 45 |
| 16 | 9 52 | 50 8 | 55956 | 9 | 44044 | 59019 | 10 | 40981 | 03063 | 1 | 96937 | 44 |
| 17 | 9 44 | 50 16 | 55988 | 9 | 44012 | 59056 | 10 | 40944 | 03068 | 1 | 96932 | 43 |
| 18 | 9 36 | 50 24 | 56021 | 10 | 43979 | 59094 | 11 | 40906 | 03073 | 1 | 96927 | 42 |
| 19 | 9 28 | 50 32 | 56053 | 10 | 43947 | 59131 | 12 | 40869 | 03078 | 2 | 96922 | 41 |
| 20 | 9 9 20 | 2 50 40 | 9.56085 | 11 | 10.43915 | 9.59168 | 12 | 10.40832 | 10.03083 | 2 | 9.96917 | 40 |
| 21 | 9 12 | 50 48 | 56118 | 11 | 43882 | 59205 | 13 | 40795 | 03088 | 2 | 96912 | 39 |
| 22 | 9 4 | 50 56 | 56150 | 12 | 43850 | 59243 | 14 | 40757 | 03093 | 2 | 96907 | 38 |
| 23 | 8 56 | 51 4 | 56182 | 12 | 43818 | 59280 | 14 | 40720 | 03097 | 2 | 96903 | 37 |
| 24 | 8 48 | 51 12 | 56215 | 13 | 43785 | 59317 | 15 | 40683 | 03102 | 2 | 96898 | 36 |
| 25 | 9 8 40 | 2 51 20 | 9.56247 | 13 | 10.43753 | 9.59354 | 15 | 10.40646 | 10.03107 | 2 | 9.96893 | 35 |
| 26 | 8 32 | 51 28 | 56279 | 14 | 43721 | 59391 | 16 | 40609 | 03112 | 2 | 96888 | 34 |
| 27 | 8 24 | 51 36 | 56311 | 14 | 43689 | 59429 | 17 | 40571 | 03117 | 2 | 96883 | 33 |
| 28 | 8 16 | 51 44 | 56343 | 15 | 43657 | 59466 | 17 | 40534 | 03122 | 2 | 96878 | 32 |
| 29 | 8 8 | 51 52 | 56375 | 16 | 43625 | 59503 | 18 | 40497 | 03127 | 2 | 96873 | 31 |
| 30 | 9 8 0 | 2 52 0 | 9.56408 | 16 | 10.43592 | 9.59540 | 19 | 10.40460 | 10.03132 | 2 | 9.96868 | 30 |
| 31 | 7 52 | 52 8 | 56440 | 17 | 43560 | 59577 | 19 | 40423 | 03137 | 3 | 96863 | 29 |
| 32 | 7 44 | 52 16 | 56472 | 17 | 43528 | 59614 | 20 | 40386 | 03142 | 3 | 96858 | 28 |
| 33 | 7 36 | 52 24 | 56504 | 18 | 43496 | 59651 | 20 | 40349 | 03147 | 3 | 96853 | 27 |
| 34 | 7 28 | 52 32 | 56536 | 18 | 43464 | 59688 | 21 | 40312 | 03152 | 3 | 96848 | 26 |
| 35 | 9 7 20 | 2 52 40 | 9.56568 | 19 | 10.43432 | 9.59725 | 22 | 10.40275 | 10.03157 | 3 | 9.96843 | 25 |
| 36 | 7 12 | 52 48 | 56599 | 19 | 43401 | 59762 | 22 | 40238 | 03162 | 3 | 96838 | 24 |
| 37 | 7 4 | 52 56 | 56631 | 20 | 43369 | 59799 | 23 | 40201 | 03167 | 3 | 96833 | 23 |
| 38 | 6 56 | 53 4 | 56663 | 20 | 43337 | 59835 | 23 | 40165 | 03172 | 3 | 96828 | 22 |
| 39 | 6 48 | 53 12 | 56695 | 21 | 43305 | 59872 | 24 | 40128 | 03177 | 3 | 96823 | 21 |
| 40 | 9 6 40 | 2 53 20 | 9.56727 | 21 | 10.43273 | 9.59909 | 25 | 10.40091 | 10.03182 | 3 | 9.96818 | 20 |
| 41 | 6 32 | 53 28 | 56759 | 22 | 43241 | 59946 | 25 | 40054 | 03187 | 3 | 96813 | 19 |
| 42 | 6 24 | 53 36 | 56790 | 22 | 43210 | 59983 | 26 | 40017 | 03192 | 3 | 96808 | 18 |
| 43 | 6 16 | 53 44 | 56822 | 23 | 43178 | 60019 | 27 | 39981 | 03197 | 4 | 96803 | 17 |
| 44 | 6 8 | 53 52 | 56854 | 24 | 43146 | 60056 | 27 | 39944 | 03202 | 4 | 96798 | 16 |
| 45 | 9 6 0 | 2 54 0 | 9.56886 | 24 | 10.43114 | 9.60093 | 28 | 10.39907 | 10.03207 | 4 | 9.96793 | 15 |
| 46 | 5 52 | 54 8 | 56917 | 25 | 43083 | 60130 | 28 | 39870 | 03212 | 4 | 96788 | 14 |
| 47 | 5 44 | 54 16 | 56949 | 25 | 43051 | 60166 | 29 | 39834 | 03217 | 4 | 96783 | 13 |
| 48 | 5 36 | 54 24 | 56980 | 26 | 43020 | 60203 | 30 | 39797 | 03222 | 4 | 96778 | 12 |
| 49 | 5 28 | 54 32 | 57012 | 26 | 42988 | 60240 | 30 | 39760 | 03228 | 4 | 96772 | 11 |
| 50 | 9 5 20 | 2 54 40 | 9.57044 | 27 | 10.42956 | 9.60276 | 31 | 10.39724 | 10.03233 | 4 | 9.96767 | 10 |
| 51 | 5 12 | 54 48 | 57075 | 27 | 42925 | 60313 | 31 | 39687 | 03238 | 4 | 96762 | 9 |
| 52 | 5 4 | 54 56 | 57107 | 28 | 42893 | 60349 | 32 | 39651 | 03243 | 4 | 96757 | 8 |
| 53 | 4 56 | 55 4 | 57138 | 28 | 42862 | 60386 | 33 | 39614 | 03248 | 4 | 96752 | 7 |
| 54 | 4 48 | 55 12 | 57169 | 29 | 42831 | 60422 | 33 | 39578 | 03253 | 4 | 96747 | 6 |
| 55 | 9 4 40 | 2 55 20 | 9.57201 | 29 | 10.42799 | 9.60459 | 34 | 10.39541 | 10.03258 | 5 | 9.96742 | 5 |
| 56 | 4 32 | 55 28 | 57232 | 30 | 42768 | 60495 | 35 | 39505 | 03263 | 5 | 96737 | 4 |
| 57 | 4 24 | 55 36 | 57264 | 30 | 42736 | 60532 | 35 | 39468 | 03268 | 5 | 96732 | 3 |
| 58 | 4 16 | 55 44 | 57295 | 31 | 42705 | 60568 | 36 | 39432 | 03273 | 5 | 96727 | 2 |
| 59 | 4 8 | 55 52 | 57326 | 32 | 42674 | 60605 | 36 | 39395 | 03278 | 5 | 96722 | 1 |
| 60 | 4 0 | 56 0 | 57358 | 32 | 42642 | 60641 | 37 | 39359 | 03283 | 5 | 96717 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| Second of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. A | 4 | 8 | 12 | 16 | 20 | 24 | 28 |
| B | 5 | 9 | 14 | 19 | 23 | 28 | 32 |
| C | 1 | 1 | 2 | 2 | 3 | 4 | 4 |

# TABLE 44.

### Log. Sines, Tangents, and Secants.

| 22° | | | A | | A | B | | B | C | | C | 157° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 9 4 0 | 2 56 0 | 9.57358 | 0 | 10.42642 | 9.60641 | 0 | 10.39359 | 10.03283 | 0 | 9.96717 | 60 |
| 1 | 3 52 | 56 8 | 57389 | 1 | 42611 | 60677 | 1 | 39323 | 03289 | 0 | 96711 | 59 |
| 2 | 3 44 | 56 16 | 57420 | 1 | 42580 | 60714 | 1 | 39286 | 03294 | 0 | 96706 | 58 |
| 3 | 3 36 | 56 24 | 57451 | 2 | 42549 | 60750 | 2 | 39250 | 03299 | 0 | 96701 | 57 |
| 4 | 3 28 | 56 32 | 57482 | 2 | 42518 | 60786 | 2 | 39214 | 03304 | 0 | 96696 | 56 |
| 5 | 9 3 20 | 2 56 40 | 9.57514 | 3 | 10.42486 | 9.60823 | 3 | 10.39177 | 10.03309 | 0 | 9.96691 | 55 |
| 6 | 3 12 | 56 48 | 57545 | 3 | 42455 | 60859 | 4 | 39141 | 03314 | 1 | 96686 | 54 |
| 7 | 3 4 | 56 56 | 57576 | 4 | 42424 | 60895 | 4 | 39105 | 03319 | 1 | 96681 | 53 |
| 8 | 2 56 | 57 4 | 57607 | 4 | 42393 | 60931 | 5 | 39069 | 03324 | 1 | 96676 | 52 |
| 9 | 2 48 | 57 12 | 57638 | 5 | 42362 | 60967 | 5 | 39033 | 03330 | 1 | 96670 | 51 |
| 10 | 9 2 40 | 2 57 20 | 9.57669 | 5 | 10.42331 | 9.61004 | 6 | 10.38996 | 10.03335 | 1 | 9.96665 | 50 |
| 11 | 2 32 | 57 28 | 57700 | 6 | 42300 | 61040 | 7 | 38960 | 03340 | 1 | 96660 | 49 |
| 12 | 2 24 | 57 36 | 57731 | 6 | 42269 | 61076 | 7 | 38924 | 03345 | 1 | 96655 | 48 |
| 13 | 2 16 | 57 44 | 57762 | 7 | 42238 | 61112 | 8 | 38888 | 03350 | 1 | 96650 | 47 |
| 14 | 2 8 | 57 52 | 57793 | 7 | 42207 | 61148 | 8 | 38852 | 03355 | 1 | 96645 | 46 |
| 15 | 9 2 0 | 2 58 0 | 9.57824 | 8 | 10.42176 | 9.61184 | 9 | 10.38816 | 10.03360 | 1 | 9.96640 | 45 |
| 16 | 1 52 | 58 8 | 57855 | 8 | 42145 | 61220 | 10 | 38780 | 03366 | 1 | 96634 | 44 |
| 17 | 1 44 | 58 16 | 57885 | 9 | 42115 | 61256 | 10 | 38744 | 03371 | 1 | 96629 | 43 |
| 18 | 1 36 | 58 24 | 57916 | 9 | 42084 | 61292 | 11 | 38708 | 03376 | 2 | 96624 | 42 |
| 19 | 1 28 | 58 32 | 57947 | 10 | 42053 | 61328 | 11 | 38672 | 03381 | 2 | 96619 | 41 |
| 20 | 9 1 20 | 2 58 40 | 9.57978 | 10 | 10.42022 | 9.61364 | 12 | 10.38636 | 10.03386 | 2 | 9.96614 | 40 |
| 21 | 1 12 | 58 48 | 58008 | 11 | 41992 | 61400 | 13 | 38600 | 03392 | 2 | 96608 | 39 |
| 22 | 1 4 | 58 56 | 58039 | 11 | 41961 | 61436 | 13 | 38564 | 03397 | 2 | 96603 | 38 |
| 23 | 0 56 | 59 4 | 58070 | 12 | 41930 | 61472 | 14 | 38528 | 03402 | 2 | 96598 | 37 |
| 24 | 0 48 | 59 12 | 58101 | 12 | 41899 | 61508 | 14 | 38492 | 03407 | 2 | 96593 | 36 |
| 25 | 9 0 40 | 2 59 20 | 9.58131 | 13 | 10.41869 | 9.61544 | 15 | 10.38456 | 10.03412 | 2 | 9.96588 | 35 |
| 26 | 0 32 | 59 28 | 58162 | 13 | 41838 | 61579 | 15 | 38421 | 03418 | 2 | 96582 | 34 |
| 27 | 0 24 | 59 36 | 58192 | 14 | 41808 | 61615 | 16 | 38385 | 03423 | 2 | 96577 | 33 |
| 28 | 0 16 | 59 44 | 58223 | 14 | 41777 | 61651 | 17 | 38349 | 03428 | 2 | 96572 | 32 |
| 29 | 0 8 | 59 52 | 58253 | 15 | 41747 | 61687 | 17 | 38313 | 03433 | 3 | 96567 | 31 |
| 30 | 9 0 0 | 3 0 0 | 9.58284 | 15 | 10.41716 | 9.61722 | 18 | 10.38278 | 10.03438 | 3 | 9.96562 | 30 |
| 31 | 8 59 52 | 0 8 | 58314 | 16 | 41686 | 61758 | 18 | 38242 | 03444 | 3 | 96556 | 29 |
| 32 | 59 44 | 0 16 | 58345 | 16 | 41655 | 61794 | 19 | 38206 | 03449 | 3 | 96551 | 28 |
| 33 | 59 36 | 0 24 | 58375 | 17 | 41625 | 61830 | 20 | 38170 | 03454 | 3 | 96546 | 27 |
| 34 | 59 28 | 0 32 | 58406 | 17 | 41594 | 61865 | 20 | 38135 | 03459 | 3 | 96541 | 26 |
| 35 | 8 59 20 | 3 0 40 | 9.58436 | 18 | 10.41564 | 9.61901 | 21 | 10.38099 | 10.03465 | 3 | 9.96535 | 25 |
| 36 | 59 12 | 0 48 | 58467 | 18 | 41533 | 61936 | 21 | 38064 | 03470 | 3 | 96530 | 24 |
| 37 | 59 4 | 0 56 | 58497 | 19 | 41503 | 61972 | 22 | 38028 | 03475 | 3 | 96525 | 23 |
| 38 | 58 56 | 1 4 | 58527 | 19 | 41473 | 62008 | 23 | 37992 | 03480 | 3 | 96520 | 22 |
| 39 | 58 48 | 1 12 | 58557 | 20 | 41443 | 62043 | 23 | 37957 | 03486 | 3 | 96514 | 21 |
| 40 | 8 58 40 | 3 1 20 | 9.58588 | 20 | 10.41412 | 9.62079 | 24 | 10.37921 | 10.03491 | 3 | 9.96509 | 20 |
| 41 | 58 32 | 1 28 | 58618 | 21 | 41382 | 62114 | 24 | 37886 | 03496 | 4 | 96504 | 19 |
| 42 | 58 24 | 1 36 | 58648 | 21 | 41352 | 62150 | 25 | 37850 | 03502 | 4 | 96498 | 18 |
| 43 | 58 16 | 1 44 | 58678 | 22 | 41322 | 62185 | 26 | 37815 | 03507 | 4 | 96493 | 17 |
| 44 | 58 8 | 1 52 | 58709 | 22 | 41291 | 62221 | 26 | 37779 | 03512 | 4 | 96488 | 16 |
| 45 | 8 58 0 | 3 2 0 | 9.58739 | 23 | 10.41261 | 9.62256 | 27 | 10.37744 | 10.03517 | 4 | 9.96483 | 15 |
| 46 | 57 52 | 2 8 | 58769 | 23 | 41231 | 62292 | 27 | 37708 | 03523 | 4 | 96477 | 14 |
| 47 | 57 44 | 2 16 | 58799 | 24 | 41201 | 62327 | 28 | 37673 | 03528 | 4 | 96472 | 13 |
| 48 | 57 36 | 2 24 | 58829 | 24 | 41171 | 62362 | 29 | 37638 | 03533 | 4 | 96467 | 12 |
| 49 | 57 28 | 2 32 | 58859 | 25 | 41141 | 62398 | 29 | 37602 | 03539 | 4 | 96461 | 11 |
| 50 | 8 57 20 | 3 2 40 | 9.58889 | 25 | 10.41111 | 9.62433 | 30 | 10.37567 | 10.03544 | 4 | 9.96456 | 10 |
| 51 | 57 12 | 2 48 | 58919 | 26 | 41081 | 62468 | 30 | 37532 | 03549 | 4 | 96451 | 9 |
| 52 | 57 4 | 2 56 | 58949 | 26 | 41051 | 62504 | 31 | 37496 | 03555 | 5 | 96445 | 8 |
| 53 | 56 56 | 3 4 | 58979 | 27 | 41021 | 62539 | 32 | 37461 | 03560 | 5 | 96440 | 7 |
| 54 | 56 48 | 3 12 | 59009 | 27 | 40991 | 62574 | 32 | 37426 | 03565 | 5 | 96435 | 6 |
| 55 | 8 56 40 | 3 3 20 | 9.59039 | 28 | 10.40961 | 9.62609 | 33 | 10.37391 | 10.03571 | 5 | 9.96429 | 5 |
| 56 | 56 32 | 3 28 | 59069 | 28 | 40931 | 62645 | 33 | 37355 | 03576 | 5 | 96424 | 4 |
| 57 | 56 24 | 3 36 | 59098 | 29 | 40902 | 62680 | 34 | 37320 | 03581 | 5 | 96419 | 3 |
| 58 | 56 16 | 3 44 | 59128 | 29 | 40872 | 62715 | 35 | 37285 | 03587 | 5 | 96413 | 2 |
| 59 | 56 8 | 3 52 | 59158 | 30 | 40842 | 62750 | 35 | 37250 | 03592 | 5 | 96408 | 1 |
| 60 | 56 0 | 4 0 | 59188 | 31 | 40812 | 62785 | 36 | 37215 | 03597 | 5 | 96403 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 112° | | | A | | A | B | | B | C | | C | 67° |

| Seconds of time ....... | | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|---|
| Prop. parts of cols. | A | 4 | 8 | 11 | 15 | 19 | 23 | 27 |
| | B | 4 | 9 | 13 | 18 | 22 | 27 | 31 |
| | C | 1 | 1 | 2 | 3 | 3 | 4 | 5 |

TABLE 44. [Page 631

Log. Sines, Tangents, and Secants.

| 23° | | | A | | A | B | | B | C | | C | 156° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 8 56 0 | 3 4 0 | 9. 59188 | 0 | 10. 40812 | 9. 62785 | 0 | 10. 37215 | 10. 03597 | 0 | 9. 96403 | 60 |
| 1 | 55 52 | 4 8 | 59218 | 0 | 40782 | 62820 | 1 | 37180 | 03603 | 0 | 96397 | 59 |
| 2 | 55 44 | 4 16 | 59247 | 1 | 40753 | 62855 | 1 | 37145 | 03608 | 0 | 96392 | 58 |
| 3 | 55 36 | 4 24 | 59277 | 1 | 40723 | 62890 | 2 | 37110 | 03613 | 0 | 96387 | 57 |
| 4 | 55 28 | 4 32 | 59307 | 2 | 40693 | 62926 | 2 | 37074 | 03619 | 0 | 96381 | 56 |
| 5 | 8 55 20 | 3 4 40 | 9. 59336 | 2 | 10. 40664 | 9. 62961 | 3 | 10. 37039 | 10. 03624 | 0 | 9. 96376 | 55 |
| 6 | 55 12 | 4 48 | 59366 | 3 | 40634 | 62996 | 3 | 37004 | 03630 | 1 | 96370 | 54 |
| 7 | 55 4 | 4 56 | 59396 | 3 | 40604 | 63031 | 4 | 36969 | 03635 | 1 | 96365 | 53 |
| 8 | 54 56 | 5 4 | 59425 | 4 | 40575 | 63066 | 5 | 36934 | 03640 | 1 | 96360 | 52 |
| 9 | 54 48 | 5 12 | 59455 | 4 | 40545 | 63101 | 5 | 36899 | 03646 | 1 | 96354 | 51 |
| 10 | 8 54 40 | 3 5 20 | 9. 59484 | 5 | 10. 40516 | 9. 63135 | 6 | 10. 36865 | 10. 03651 | 1 | 9. 96349 | 50 |
| 11 | 54 32 | 5 28 | 59514 | 5 | 40486 | 63170 | 6 | 36830 | 03657 | 1 | 96343 | 49 |
| 12 | 54 24 | 5 36 | 59543 | 6 | 40457 | 63205 | 7 | 36795 | 03662 | 1 | 96338 | 48 |
| 13 | 54 16 | 5 44 | 59573 | 6 | 40427 | 63240 | 7 | 36760 | 03667 | 1 | 96333 | 47 |
| 14 | 54 8 | 5 52 | 59602 | 7 | 40398 | 63275 | 8 | 36725 | 03673 | 1 | 96327 | 46 |
| 15 | 8 54 0 | 3 6 0 | 9. 59632 | 7 | 10. 40368 | 9. 63310 | 9 | 10. 36690 | 10. 03678 | 1 | 9. 96322 | 45 |
| 16 | 53 52 | 6 8 | 59661 | 8 | 40339 | 63345 | 9 | 36655 | 03684 | 1 | 96316 | 44 |
| 17 | 53 44 | 6 16 | 59690 | 8 | 40310 | 63379 | 10 | 36621 | 03689 | 2 | 96311 | 43 |
| 18 | 53 36 | 6 24 | 59720 | 9 | 40280 | 63414 | 10 | 36586 | 03695 | 2 | 96305 | 42 |
| 19 | 53 28 | 6 32 | 59749 | 9 | 40251 | 63449 | 11 | 36551 | 03700 | 2 | 96300 | 41 |
| 20 | 8 53 20 | 3 6 40 | 9. 59778 | 10 | 10. 40222 | 9. 63484 | 12 | 10. 36516 | 10. 03706 | 2 | 9. 96294 | 40 |
| 21 | 53 12 | 6 48 | 59808 | 10 | 40192 | 63519 | 12 | 36481 | 03711 | 2 | 96289 | 39 |
| 22 | 53 4 | 6 56 | 59837 | 11 | 40163 | 63553 | 13 | 36447 | 03716 | 2 | 96284 | 38 |
| 23 | 52 56 | 7 4 | 59866 | 11 | 40134 | 63588 | 13 | 36412 | 03722 | 2 | 96278 | 37 |
| 24 | 52 48 | 7 12 | 59895 | 12 | 40105 | 63623 | 14 | 36377 | 03727 | 2 | 96273 | 36 |
| 25 | 8 52 40 | 3 7 20 | 9. 59924 | 12 | 10. 40076 | 9. 63657 | 14 | 10. 36343 | 10. 03733 | 2 | 9. 96267 | 35 |
| 26 | 52 32 | 7 28 | 59954 | 13 | 40046 | 63692 | 15 | 36308 | 03738 | 2 | 96262 | 34 |
| 27 | 52 24 | 7 36 | 59983 | 13 | 40017 | 63726 | 16 | 36274 | 03744 | 2 | 96256 | 33 |
| 28 | 52 16 | 7 44 | 60012 | 14 | 39988 | 63761 | 16 | 36239 | 03749 | 3 | 96251 | 32 |
| 29 | 52 8 | 7 52 | 60041 | 14 | 39959 | 63796 | 17 | 36204 | 03755 | 3 | 96245 | 31 |
| 30 | 8 52 0 | 3 8 0 | 9. 60070 | 15 | 10. 39930 | 9. 63830 | 17 | 10. 36170 | 10. 03760 | 3 | 9. 96240 | 30 |
| 31 | 51 52 | 8 8 | 60099 | 15 | 39901 | 63865 | 18 | 36135 | 03766 | 3 | 96234 | 29 |
| 32 | 51 44 | 8 16 | 60128 | 15 | 39872 | 63899 | 18 | 36101 | 03771 | 3 | 96229 | 28 |
| 33 | 51 36 | 8 24 | 60157 | 16 | 39843 | 63934 | 19 | 36066 | 03777 | 3 | 96223 | 27 |
| 34 | 51 28 | 8 32 | 60186 | 16 | 39814 | 63968 | 20 | 36032 | 03782 | 3 | 96218 | 26 |
| 35 | 8 51 20 | 3 8 40 | 9. 60215 | 17 | 10. 39785 | 9. 64003 | 20 | 10. 35997 | 10. 03788 | 3 | 9. 96212 | 25 |
| 36 | 51 12 | 8 48 | 60244 | 17 | 39756 | 64037 | 21 | 35963 | 03793 | 3 | 96207 | 24 |
| 37 | 51 4 | 8 56 | 60273 | 18 | 39727 | 64072 | 21 | 35928 | 03799 | 3 | 96201 | 23 |
| 38 | 50 56 | 9 4 | 60302 | 18 | 39698 | 64106 | 22 | 35894 | 03804 | 3 | 96196 | 22 |
| 39 | 50 48 | 9 12 | 60331 | 19 | 39669 | 64140 | 22 | 35860 | 03810 | 4 | 96190 | 21 |
| 40 | 8 50 40 | 3 9 20 | 9. 60359 | 19 | 10. 39641 | 9. 64175 | 23 | 10. 35825 | 10. 03815 | 4 | 9. 96185 | 20 |
| 41 | 50 32 | 9 28 | 60388 | 20 | 39612 | 64209 | 24 | 35791 | 03821 | 4 | 96179 | 19 |
| 42 | 50 24 | 9 36 | 60417 | 20 | 39583 | 64243 | 24 | 35757 | 03826 | 4 | 96174 | 18 |
| 43 | 50 16 | 9 44 | 60446 | 21 | 39554 | 64278 | 25 | 35722 | 03832 | 4 | 96168 | 17 |
| 44 | 50 8 | 9 52 | 60474 | 21 | 39526 | 64312 | 25 | 35688 | 03838 | 4 | 96162 | 16 |
| 45 | 8 50 0 | 3 10 0 | 9. 60503 | 22 | 10. 39497 | 9. 64346 | 26 | 10. 35654 | 10. 03843 | 4 | 9. 96157 | 15 |
| 46 | 49 52 | 10 8 | 60532 | 22 | 39468 | 64381 | 26 | 35619 | 03849 | 4 | 96151 | 14 |
| 47 | 49 44 | 10 16 | 60561 | 23 | 39439 | 64415 | 27 | 35585 | 03854 | 4 | 96146 | 13 |
| 48 | 49 36 | 10 24 | 60589 | 23 | 39411 | 64449 | 28 | 35551 | 03860 | 4 | 96140 | 12 |
| 49 | 49 28 | 10 32 | 60618 | 24 | 39382 | 64483 | 28 | 35517 | 03865 | 4 | 96135 | 11 |
| 50 | 8 49 20 | 3 10 40 | 9. 60646 | 24 | 10. 39354 | 9. 64517 | 29 | 10. 35483 | 10. 03871 | 5 | 9. 96129 | 10 |
| 51 | 49 12 | 10 48 | 60675 | 25 | 39325 | 64552 | 29 | 35448 | 03877 | 5 | 96123 | 9 |
| 52 | 49 4 | 10 56 | 60704 | 25 | 39296 | 64586 | 30 | 35414 | 03882 | 5 | 96118 | 8 |
| 53 | 48 56 | 11 4 | 60732 | 26 | 39268 | 64620 | 31 | 35380 | 03888 | 5 | 96112 | 7 |
| 54 | 48 48 | 11 12 | 60761 | 26 | 39239 | 64654 | 31 | 35346 | 03893 | 5 | 96107 | 6 |
| 55 | 8 48 40 | 3 11 20 | 9. 60789 | 27 | 10. 39211 | 9. 64688 | 32 | 10. 35312 | 10. 03899 | 5 | 9. 96101 | 5 |
| 56 | 48 32 | 11 28 | 60818 | 27 | 39182 | 64722 | 32 | 35278 | 03905 | 5 | 96095 | 4 |
| 57 | 48 24 | 11 36 | 60846 | 28 | 39154 | 64756 | 33 | 35244 | 03910 | 5 | 96090 | 3 |
| 58 | 48 16 | 11 44 | 60875 | 28 | 39125 | 64790 | 33 | 35210 | 03916 | 5 | 96084 | 2 |
| 59 | 48 8 | 11 52 | 60903 | 29 | 39097 | 64824 | 34 | 35176 | 03921 | 5 | 96079 | 1 |
| 60 | 48 0 | 12 0 | 60931 | 29 | 39069 | 64858 | 35 | 35142 | 03927 | 6 | 96073 | 0 |

| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 113° | | | A | | A | B | | B | C | | C | 66° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 4 | 7 | 11 | 15 | 18 | 22 | 25 |
| B | 4 | 9 | 13 | 17 | 22 | 26 | 31 |
| C | 1 | 1 | 2 | 3 | 3 | 4 | 5 |

## TABLE 44.

Log. Sines, Tangents, and Secants.

24°                                                                                    155°

| M. | Hour A. M. | Hour P. M. | A Sine. | Diff. | A Cosecant. | B Tangent. | Diff. | B Cotangent. | C Secant. | Diff. | C Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 8 48 0 | 3 12 0 | 9. 60931 | 0 | 10. 39069 | 9. 64858 | 0 | 10. 35142 | 10. 03927 | 0 | 9. 96073 | 60 |
| 1 | 47 52 | 12 8 | 60960 | 0 | 39040 | 64892 | 1 | 35108 | 03933 | 0 | 96067 | 59 |
| 2 | 47 44 | 12 16 | 60988 | 1 | 39012 | 64926 | 1 | 35074 | 03938 | 0 | 96062 | 58 |
| 3 | 47 36 | 12 24 | 61016 | 1 | 38984 | 64960 | 2 | 35040 | 03944 | 0 | 96056 | 57 |
| 4 | 47 28 | 12 32 | 61045 | 2 | 38955 | 64994 | 2 | 35006 | 03950 | 0 | 96050 | 56 |
| 5 | 8 47 20 | 3 12 40 | 9. 61073 | 2 | 10. 38927 | 9. 65028 | 3 | 10. 34972 | 10. 03955 | 0 | 9. 96045 | 55 |
| 6 | 47 12 | 12 48 | 61101 | 3 | 38899 | 65062 | 3 | 34938 | 03961 | 1 | 96039 | 54 |
| 7 | 47 4 | 12 56 | 61129 | 3 | 38871 | 65096 | 4 | 34904 | 03966 | 1 | 96034 | 53 |
| 8 | 46 56 | 13 4 | 61158 | 4 | 38842 | 65130 | 4 | 34870 | 03972 | 1 | 96028 | 52 |
| 9 | 46 48 | 13 12 | 61186 | 4 | 38814 | 65164 | 5 | 34836 | 03978 | 1 | 96022 | 51 |
| 10 | 8 46 40 | 3 13 20 | 9. 61214 | 5 | 10. 38786 | 9. 65197 | 6 | 10. 34803 | 10. 03983 | 1 | 9. 96017 | 50 |
| 11 | 46 32 | 13 28 | 61242 | 5 | 38758 | 65231 | 6 | 34769 | 03989 | 1 | 96011 | 49 |
| 12 | 46 24 | 13 36 | 61270 | 6 | 38730 | 65265 | 7 | · 34735 | 03995 | 1 | 96005 | 48 |
| 13 | 46 16 | 13 44 | 61298 | 6 | 38702 | 65299 | 7 | 34701 | 04000 | 1 | 96000 | 47 |
| 14 | 46 8 | 13 52 | 61326 | 6 | 38674 | 65333 | 8 | 34667 | 04006 | 1 | 95994 | 46 |
| 15 | 8 46 0 | 3 14 0 | 9. 61354 | 7 | 10. 38646 | 9. 65366 | 8 | 10. 34634 | 10. 04012 | 1 | 9. 95988 | 45 |
| 16 | 45 52 | 14 8 | 61382 | 7 | 38618 | 65400 | 9 | 34600 | 04018 | 2 | 95982 | 44 |
| 17 | 45 44 | 14 16 | 61411 | 8 | 38589 | 65434 | 9 | 34566 | 04023 | 2 | 95977 | 43 |
| 18 | 45 36 | 14 24 | 61438 | 8 | 38562 | 65467 | 10 | 34533 | 04029 | 2 | 95971 | 42 |
| 19 | 45 28 | 14 32 | 61466 | 9 | 38534 | 65501 | 11 | 34499 | 04035 | 2 | 95965 | 41 |
| 20 | 8 45 20 | 3 14 40 | 9. 61494 | 9 | 10. 38506 | 9. 65535 | 11 | 10. 34465 | 10. 04040 | 2 | 9. 95960 | 40 |
| 21 | 45 12 | 14 48 | 61522 | 10 | 38478 | 65568 | 12 | 34432 | 04046 | 2 | 95954 | 39 |
| 22 | 45 4 | 14 56 | 61550 | 10 | 38450 | 65602 | 12 | 34398 | 04052 | 2 | 95948 | 38 |
| 23 | 44 56 | 15 4 | 61578 | 11 | 38422 | 65636 | 13 | 34364 | 04058 | 2 | 95942 | 37 |
| 24 | 44 48 | 15 12 | 61606 | 11 | 38394 | 65669 | 13 | 34331 | 04063 | 2 | 95937 | 36 |
| 25 | 8 44 40 | 3 15 20 | 9. 61634 | 12 | 10. 38366 | 9. 65703 | 14 | 10. 34297 | 10. 04069 | 2 | 9. 95931 | 35 |
| 26 | 44 32 | 15 28 | 61662 | 12 | 38338 | 65736 | 15 | 34264 | 04075 | 2 | 95925 | 34 |
| 27 | 44 24 | 15 36 | 61689 | 12 | 38311 | 65770 | 15 | 34230 | 04080 | 3 | 95920 | 33 |
| 28 | 44 16 | 15 44 | 61717 | 13 | 38283 | 65803 | 16 | 34197 | 04086 | 3 | 95914 | 32 |
| 29 | 44 8 | 15 52 | 61745 | 13 | 38255 | 65837 | 16 | 34163 | 04092 | 3 | 95908 | 31 |
| 30 | 8 44 0 | 3 16 0 | 9. 61773 | 14 | 10. 38227 | 9. 65870 | 17 | 10. 34130 | 10. 04098 | 3 | 9. 95902 | 30 |
| 31 | 43 52 | 16 8 | 61800 | 14 | 38200 | 65904 | 17 | 34096 | 04103 | 3 | 95897 | 29 |
| 32 | 43 44 | 16 16 | 61828 | 15 | 38172 | 65937 | 18 | 34063 | 04109 | 3 | 95891 | 28 |
| 33 | 43 36 | 16 24 | 61856 | 15 | 38144 | 65971 | 18 | 34029 | 04115 | 3 | 95885 | 27 |
| 34 | 43 28 | 16 32 | 61883 | 16 | 38117 | 66004 | 19 | 33996 | 04121 | 3 | 95879 | 26 |
| 35 | 8 43 20 | 3 16 40 | 9. 61911 | 16 | 10. 38089 | 9. 66038 | 20 | 10. 33962 | 10. 04127 | 3 | 9. 95873 | 25 |
| 36 | 43 12 | 16 48 | 61939 | 17 | 38061 | 66071 | 20 | 33929 | 04132 | 3 | 95868 | 24 |
| 37 | 43 4 | 16 56 | 61966 | 17 | 38034 | 66104 | 21 | 33896 | 04138 | 4 | 95862 | 23 |
| 38 | 42 56 | 17 4 | 61994 | 18 | 38006 | 66138 | 21 | 33862 | 04144 | 4 | 95856 | 22 |
| 39 | 42 48 | 17 12 | 62021 | 18 | 37979 | 66171 | 22 | 33829 | 04150 | 4 | 95850 | .21 |
| 40 | 8 42 40 | 3 17 20 | 9. 62049 | 18 | 10. 37951 | 9. 66204 | 22 | 10. 33796 | 10. 04156 | 4 | 9. 95844 | 20 |
| 41 | 42 32 | 17 28 | 62076 | 19 | 37924 | 66238 | 23 | 33762 | 04161 | 4 | 95839 | 19 |
| 42 | 42 24 | 17 36 | 62104 | 19 | 37896 | 66271 | 23 | 33729 | 04167 | 4 | 95833 | 18 |
| 43 | 42 16 | 17 44 | 62131 | 20 | 37869 | 66304 | 24 | 33696 | 04173 | 4 | 95827 | 17 |
| 44 | 42 8 | 17 52 | 62159 | 20 | 37841 | 66337 | 25 | 33663 | 04179 | 4 | 95821 | 16 |
| 45 | 8 42 0 | 3 18 0 | 9. 62186 | 21 | 10. 37814 | 9. 66371 | 25 | 10. 33629 | 10. 04185 · | 4 | 9. 95815 | 15 |
| 46 | 41 52 | 18 8 | 62214 | 21 | 37786 | 66404 | 26 | 33596 | 04190 | 4 | 95810 | 14 |
| 47 | 41 44 | 18 16 | 62241 | 22 | 37759 | 66437 | 26 | 33563 | 04196 | 5 | 95804 | 13 |
| 48 | 41 36 | 18 24 | 62268 | 22 | 37732 | 66470 | 27 | 33530 | 04202 | 5 | 95798 | 12 |
| 49 | 41 28 | 18 32 | 62296 | 23 | 37704 | 66503 | 27 | 33497 | 04208 | 5 | 95792 | 11 |
| 50 | 8 41 20 | 3 18 40 | 9. 62323 | 23 | 10. 37677 | 9. 66537 | 28 | 10. 33463 | 10. 04214 | 5 | 9. 95786 | 10 |
| 51 | 41 12 | 18 48 | 62350 | 24 | 37650 | 66570 | 28 | 33430 | 04220 | 5 | 95780 | 9 |
| 52 | 41 4 | 18 56 | 62377 | 24 | 37623 | 66603 | 29 | 33397 | 04225 | 5 | 95775 | 8 |
| 53 | 40 56 | 19 4 | 62405 | 24 | 37595 | 66636 | 30 | 33364 | 04231 | 5 | 95769 | 7 |
| 54 | 40 48 | 19 12 | 62432 | 25 | 37568 | 66669 | 30 | ·33331 | 04237 | 5 | 95763 | 6 |
| 55 | 8 40 40 | 3 19 20 | 9. 62459 | 25 | 10. 37541 | 9. 66702 | 31 | 10. 33298 | 10. 04243 | 5 | 9. 95757 | 5 |
| 56 | 40 32 | 19 28 | 62486 | 26 | 37514 | 66735 | 31 | 33265 | 04249 | 5 | 95751 | 4 |
| 57 | 40 24 | 19 36 | 62513 | 26 | 37487 | 66768 | 32 . | 33232 | 04255 | 5 | 95745 | 3 |
| 58 | 40 16 | 19 44 | 62541 | 27 | 37459 | 66801 | 32 | 33199 | 04261 | 6 | 95739 | 2 |
| 59 | 40 8 | 19 52 | 62568 | 27 | 37432 | 66834 | 33 | 33166 | 04267 | 6 | 95733 | 1 |
| 60 | 40 0 | 20 0 | 62595 | 28 | 37405 | 66867 | 33 | 33133 | 04272 | 6 | 95728 | 0 |

| M. | Hour P. M. | Hour A. M | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 114° |  |  | A |  | A | B |  | B | C |  | C | 65° |

| Seconds of time........ | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 3 | 7 | 10 | 14 | 17 | 21 | 24 |
| {B | 4 | 8 | 13 | 17 | 21 | 25 | 29 |
| {C | 1 | 1 | 2 | 3 | 4 | 4 | 5 |

TABLE 44.

Page 633

Log. Sines, Tangents, and Secants.

| 25° | | | A | | A | B | | B | C | | C | 154° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 8 40 0 | 3 20 0 | 9.62595 | 0 | 10.37405 | 9.66867 | 0 | 10.33133 | 10.04272 | 0 | 9.95728 | 60 |
| 1 | 39 52 | 20 8 | 62622 | 0 | 37378 | 66900 | 1 | 33100 | 04278 | 0 | 95722 | 59 |
| 2 | 39 44 | 20 16 | 62649 | 1 | 37351 | 66933 | 1 | 33067 | 04284 | 0 | 95716 | 58 |
| 3 | 39 36 | 20 24 | 62676 | 1 | 37324 | 66966 | 2 | 33034 | 04290 | 0 | 95710 | 57 |
| 4 | 39 28 | 20 32 | 62703 | 2 | 37297 | 66999 | 2 | 33001 | 04296 | 0 | 95704 | 56 |
| 5 | 8 39 20 | 3 20 40 | 9.62730 | 2 | 10.37270 | 9.67032 | 3 | 10.32968 | 10.04302 | 1 | 9.95698 | 55 |
| 6 | 39 12 | 20 48 | 62757 | 3 | 37243 | 67065 | 3 | 32935 | 04308 | 1 | 95692 | 54 |
| 7 | 39 4 | 20 56 | 62784 | 3 | 37216 | 67098 | 4 | 32902 | 04314 | 1 | 95686 | 53 |
| 8 | 38 56 | 21 4 | 62811 | 4 | 37189 | 67131 | 4 | 32869 | 04320 | 1 | 95680 | 52 |
| 9 | 38 48 | 21 12 | 62838 | 4 | 37162 | 67163 | 5 | 32837 | 04326 | 1 | 95674 | 51 |
| 10 | 8 38 40 | 3 21 20 | 9.62865 | 4 | 10.37135 | 9.67196 | 5 | 10.32804 | 10.04332 | 1 | 9.95668 | 50 |
| 11 | 38 32 | 21 28 | 62892 | 5 | 37108 | 67229 | 6 | 32771 | 04337 | 1 | 95663 | 49 |
| 12 | 38 24 | 21 36 | 62918 | 5 | 37082 | 67262 | 7 | 32738 | 04343 | 1 | 95657 | 48 |
| 13 | 38 16 | 21 44 | 62945 | 6 | 37055 | 67295 | 7 | 32705 | 04349 | 1 | 95651 | 47 |
| 14 | 38 8 | 21 52 | 62972 | 6 | 37028 | 67327 | 8 | 32673 | 04355 | 1 | 95645 | 46 |
| 15 | 8 38 0 | 3 22 0 | 9.62999 | 7 | 10.37001 | 9.67360 | 8 | 10.32640 | 10.04361 | 2 | 9.95639 | 45 |
| 16 | 37 52 | 22 8 | 63026 | 7 | 36974 | 67393 | 9 | 32607 | 04367 | 2 | 95633 | 44 |
| 17 | 37 44 | 22 16 | 63052 | 8 | 36948 | 67426 | 9 | 32574 | 04373 | 2 | 95627 | 43 |
| 18 | 37 36 | 22 24 | 63079 | 8 | 36921 | 67458 | 10 | 32542 | 04379 | 2 | 95621 | 42 |
| 19 | 37 28 | 22 32 | 63106 | 8 | 36894 | 67491 | 10 | 32509 | 04385 | 2 | 95615 | 41 |
| 20 | 8 37 20 | 3 22 40 | 9.63133 | 9 | 10.36867 | 9.67524 | 11 | 10.32476 | 10.04391 | 2 | 9.95609 | 40 |
| 21 | 37 12 | 22 48 | 63159 | 9 | 36841 | 67556 | 11 | 32444 | 04397 | 2 | 95603 | 39 |
| 22 | 37 4 | 22 56 | 63186 | 10 | 36814 | 67589 | 12 | 32411 | 04403 | 2 | 95597 | 38 |
| 23 | 36 56 | 23 4 | 63213 | 10 | 36787 | 67622 | 12 | 32378 | 04409 | 2 | 95591 | 37 |
| 24 | 36 48 | 23 12 | 63239 | 11 | 36761 | 67654 | 13 | 32346 | 04415 | 2 | 95585 | 36 |
| 25 | 8 36 40 | 3 23 20 | 9.63266 | 11 | 10.36734 | 9.67687 | 14 | 10.32313 | 10.04421 | 3 | 9.95579 | 35 |
| 26 | 36 32 | 23 28 | 63292 | 11 | 36708 | 67719 | 14 | 32281 | 04427 | 3 | 95573 | 34 |
| 27 | 36 24 | 23 36 | 63319 | 12 | 36681 | 67752 | 15 | 32248 | 04433 | 3 | 95567 | 33 |
| 28 | 36 16 | 23 44 | 63345 | 12 | 36655 | 67785 | 15 | 32215 | 04439 | 3 | 95561 | 32 |
| 29 | 36 8 | 23 52 | 63372 | 13 | 36628 | 67817 | 16 | 32183 | 04445 | 3 | 95555 | 31 |
| 30 | 8 36 0 | 3 24 0 | 9.63398 | 13 | 10.36602 | 9.67850 | 16 | 10.32150 | 10.04451 | 3 | 9.95549 | 30 |
| 31 | 35 52 | 24 8 | 63425 | 14 | 36575 | 67882 | 17 | 32118 | 04457 | 3 | 95543 | 29 |
| 32 | 35 44 | 24 16 | 63451 | 14 | 36549 | 67915 | 17 | 32085 | 04463 | 3 | 95537 | 28 |
| 33 | 35 36 | 24 24 | 63478 | 15 | 36522 | 67947 | 18 | 32053 | 04469 | 3 | 95531 | 27 |
| 34 | 35 28 | 24 32 | 63504 | 15 | 36496 | 67980 | 18 | 32020 | 04475 | 3 | 95525 | 26 |
| 35 | 8 35 20 | 3 24 40 | 9.63531 | 15 | 10.36469 | 9.68012 | 19 | 10.31988 | 10.04481 | 4 | 9.95519 | 25 |
| 36 | 35 12 | 24 48 | 63557 | 16 | 36443 | 68044 | 20 | 31956 | 04487 | 4 | 95513 | 24 |
| 37 | 35 4 | 24 56 | 63583 | 16 | 36417 | 68077 | 20 | 31923 | 04493 | 4 | 95507 | 23 |
| 38 | 34 56 | 25 4 | 63610 | 17 | 36390 | 68109 | 21 | 31891 | 04500 | 4 | 95500 | 22 |
| 39 | 34 48 | 25 12 | 63636 | 17 | 36364 | 68142 | 21 | 31858 | 04506 | 4 | 95494 | 21 |
| 40 | 8 34 40 | 3 25 20 | 9.63662 | 18 | 10.36338 | 9.68174 | 22 | 10.31826 | 10.04512 | 4 | 9.95488 | 20 |
| 41 | 34 32 | 25 28 | 63689 | 18 | 36311 | 68206 | 22 | 31794 | 04518 | 4 | 95482 | 19 |
| 42 | 34 24 | 25 36 | 63715 | 19 | 36285 | 68239 | 23 | 31761 | 04524 | 4 | 95476 | 18 |
| 43 | 34 16 | 25 44 | 63741 | 19 | 36259 | 68271 | 23 | 31729 | 04530 | 4 | 95470 | 17 |
| 44 | 34 8 | 25 52 | 63767 | 19 | 36233 | 68303 | 24 | 31697 | 04536 | 4 | 95464 | 16 |
| 45 | 8 34 0 | 3 26 0 | 9.63794 | 20 | 10.36206 | 9.68336 | 24 | 10.31664 | 10.04542 | 5 | 9.95458 | 15 |
| 46 | 33 52 | 26 8 | 63820 | 20 | 36180 | 68368 | 25 | 31632 | 04548 | 5 | 95452 | 14 |
| 47 | 33 44 | 26 16 | 63846 | 21 | 36154 | 68400 | 25 | 31600 | 04554 | 5 | 95446 | 13 |
| 48 | 33 36 | 26 24 | 63872 | 21 | 36128 | 68432 | 26 | 31568 | 04560 | 5 | 95440 | 12 |
| 49 | 33 28 | 26 32 | 63898 | 22 | 36102 | 68465 | 27 | 31535 | 04566 | 5 | 95434 | 11 |
| 50 | 8 33 20 | 3 26 40 | 9.63924 | 22 | 10.36076 | 9.68497 | 27 | 10.31503 | 10.04573 | 5 | 9.95427 | 10 |
| 51 | 33 12 | 26 48 | 63950 | 23 | 36050 | 68529 | 28 | 31471 | 04579 | 5 | 95421 | 9 |
| 52 | 33 4 | 26 56 | 63976 | 23 | 36024 | 68561 | 28 | 31439 | 04585 | 5 | 95415 | 8 |
| 53 | 32 56 | 27 4 | 64002 | 23 | 35998 | 68593 | 29 | 31407 | 04591 | 5 | 95409 | 7 |
| 54 | 32 48 | 27 12 | 64028 | 24 | 35972 | 68626 | 29 | 31374 | 04597 | 5 | 95403 | 6 |
| 55 | 8 32 40 | 3 27 20 | 9.64054 | 24 | 10.35946 | 9.68658 | 30 | 10.31342 | 10.04603 | 6 | 9.95397 | 5 |
| 56 | 32 32 | 27 28 | 64080 | 25 | 35920 | 68690 | 30 | 31310 | 04609 | 6 | 95391 | 4 |
| 57 | 32 24 | 27 36 | 64106 | 25 | 35894 | 68722 | 31 | 31278 | 04616 | 6 | 95384 | 3 |
| 58 | 32 16 | 27 44 | 64132 | 26 | 35868 | 68754 | 31 | 31246 | 04622 | 6 | 95378 | 2 |
| 59 | 32 8 | 27 52 | 64158 | 26 | 35842 | 68786 | 32 | 31214 | 04628 | 6 | 95372 | 1 |
| 60 | 32 0 | 28 0 | 64184 | 26 | 35816 | 68818 | 33 | 31182 | 04634 | 6 | 95366 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 115° | | | A | | A | B | | B | C | | C | 64° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 3 | 7 | 10 | 13 | 17 | 20 | 23 |
| B | 4 | 8 | 12 | 16 | 20 | 24 | 28 |
| C | ·1 | 2 | 2 | 3 | 4 | 5 | 5 |

# TABLE 44.

### Log. Sines, Tangents, and Secants.

| 26° | | | A | | A | B | | B | C | | C | 153° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Coseeant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 8 32 0 | 3 28 0 | 9.64184 | 0 | 10.35816 | 9.68818 | 0 | 10.31182 | 10.04634 | 0 | 9.95366 | 60 |
| 1 | 31 52 | 28 8 | 64210 | 0 | 35790 | 68850 | 1 | 31150 | 04640 | 0 | 95360 | 59 |
| 2 | 31 44 | 28 16 | 64236 | 1 | 35764 | 68882 | 1 | 31118 | 04646 | 0 | 95354 | 58 |
| 3 | 31 36 | 28 24 | 64262 | 1 | 35738 | 68914 | 2 | 31086 | 04652 | 0 | 95348 | 57 |
| 4 | 31 28 | 28 32 | 64288 | 2 | 35712 | 68946 | 2 | 31054 | 04659 | 0 | 95341 | 56 |
| 5 | 8 31 20 | 3 28 40 | 9.64313 | 2 | 10.35687 | 9.68978 | 3 | 10.31022 | 10.04665 | 1 | 9.95335 | 55 |
| 6 | 31 12 | 28 48 | 64339 | 3 | 35661 | 69010 | 3 | 30990 | 04671 | 1 | 95329 | 54 |
| 7 | 31 4 | 28 56 | 64365 | 3 | 35635 | 69042 | 4 | 30958 | 04677 | 1 | 95323 | 53 |
| 8 | 30 56 | 29 4 | 64391 | 3 | 35609 | 69074 | 4 | 30926 | 04683 | 1 | 95317 | 52 |
| 9 | 30 48 | 29 12 | 64417 | 4 | 35583 | 69106 | 5 | 30894 | 04690 | 1 | 95310 | 51 |
| 10 | 8 30 40 | 3 29 20 | 9.64442 | 4 | 10.35558 | 9.69138 | 5 | 10.30862 | 10.04696 | 1 | 9.95304 | 50 |
| 11 | 30 32 | 29 28 | 64468 | 5 | 35532 | 69170 | 6 | 30830 | 04702 | 1 | 95298 | 49 |
| 12 | 30 24 | 29 36 | 64494 | 5 | 35506 | 69202 | 6 | 30798 | 04708 | 1 | 95292 | 48 |
| 13 | 30 16 | 29 44 | 64519 | 5 | 35481 | 69234 | 7 | 30766 | 04714 | 1 | 95286 | 47 |
| 14 | 30 8 | 29 52 | 64545 | 6 | 35455 | 69266 | 7 | 30734 | 04721 | 1 | 95279 | 46 |
| 15 | 8 30 0 | 3 30 0 | 9.64571 | 6 | 10.35429 | 9.69298 | 8 | 10.30702 | 10.04727 | 2 | 9.95273 | 45 |
| 16 | 29 52 | 30 8 | 64596 | 7 | 35404 | 69329 | 8 | 30671 | 04733 | 2 | 95267 | 44 |
| 17 | 29 44 | 30 16 | 64622 | 7 | 35378 | 69361 | 9 | 30639 | 04739 | 2 | 95261 | 43 |
| 18 | 29 36 | 30 24 | 64647 | 8 | 35353 | 69393 | 9 | 30607 | 04746 | 2 | 95254 | 42 |
| 19 | 29 28 | 30 32 | 64673 | 8 | 35327 | 69425 | 10 | 30575 | 04752 | 2 | 95248 | 41 |
| 20 | 8 29 20 | 3 30 40 | 9.64698 | 8 | 10.35302 | 9.69457 | 11 | 10.30543 | 10.04758 | 2 | 9.95242 | 40 |
| 21 | 29 12 | 30 48 | 64724 | 9 | 35276 | 69488 | 11 | 30512 | 04764 | 2 | 95236 | 39 |
| 22 | 29 4 | 30 56 | 64749 | 9 | 35251 | 69520 | 12 | 30480 | 04771 | 2 | 95229 | 38 |
| 23 | 28 56 | 31 4 | 64775 | 10 | 35225 | 69552 | 12 | 30448 | 04777 | 2 | 95223 | 37 |
| 24 | 28 48 | 31 12 | 64800 | 10 | 35200 | 69584 | 13 | 30416 | 04783 | 3 | 95217 | 36 |
| 25 | 8 28 40 | 3 31 20 | 9.64826 | 11 | 10.35174 | 9.69615 | 13 | 10.30385 | 10.04789 | 3 | 9.95211 | 35 |
| 26 | 28 32 | 31 28 | 64851 | 11 | 35149 | 69647 | 14 | 30353 | 04796 | 3 | 95204 | 34 |
| 27 | 28 24 | 31 36 | 64877 | 11 | 35123 | 69679 | 14 | 30321 | 04802 | 3 | 95198 | 33 |
| 28 | 28 16 | 31 44 | 64902 | 12 | 35098 | 69710 | 15 | 30290 | 04808 | 3 | 95192 | 32 |
| 29 | 28 8 | 31 52 | 64927 | 12 | 35073 | 69742 | 15 | 30258 | 04815 | 3 | 95185 | 31 |
| 30 | 8 28 0 | 3 32 0 | 9.64953 | 13 | 10.35047 | 9.69774 | 16 | 10.30226 | 10.04821 | 3 | 9.95179 | 30 |
| 31 | 27 52 | 32 8 | 64978 | 13 | 35022 | 69805 | 16 | 30195 | 04827 | 3 | 95173 | 29 |
| 32 | 27 44 | 32 16 | 65003 | 14 | 34997 | 69837 | 17 | 30163 | 04833 | 3 | 95167 | 28 |
| 33 | 27 36 | 32 24 | 65029 | 14 | 34971 | 69868 | 17 | 30132 | 04840 | 3 | 95160 | 27 |
| 34 | 27 28 | 32 32 | 65054 | 14 | 34946 | 69900 | 18 | 30100 | 04846 | 4 | 95154 | 26 |
| 35 | 8 27 20 | 3 32 40 | 9.65079 | 15 | 10.34921 | 9.69932 | 18 | 10.30068 | 10.04852 | 4 | 9.95148 | 25 |
| 36 | 27 12 | 32 48 | 65104 | 15 | 34896 | 69963 | 19 | 30037 | 04859 | 4 | 95141 | 24 |
| 37 | 27 4 | 32 56 | 65130 | 16 | 34870 | 69995 | 20 | 30005 | 04865 | 4 | 95135 | 23 |
| 38 | 26 56 | 33 4 | 65155 | 16 | 34845 | 70026 | 20 | 29974 | 04871 | 4 | 95129 | 22 |
| 39 | 26 48 | 33 12 | 65180 | 16 | 34820 | 70058 | 21 | 29942 | 04878 | 4 | 95122 | 21 |
| 40 | 8 26 40 | 3 33 20 | 9.65205 | 17 | 10.34795 | 9.70089 | 21 | 10.29911 | 10.04884 | 4 | 9.95116 | 20 |
| 41 | 26 32 | 33 28 | 65230 | 17 | 34770 | 70121 | 22 | 29879 | 04890 | 4 | 95110 | 19 |
| 42 | 26 24 | 33 36 | 65255 | 18 | 34745 | 70152 | 22 | 29848 | 04897 | 4 | 95103 | 18 |
| 43 | 26 16 | 33 44 | 65281 | 18 | 34719 | 70184 | 23 | 29816 | 04903 | 5 | 95097 | 17 |
| 44 | 26 8 | 33 52 | 65306 | 19 | 34694 | 70215 | 23 | 29785 | 04910 | 5 | 95090 | 16 |
| 45 | 8 26 0 | 3 34 0 | 9.65331 | 19 | 10.34669 | 9.70247 | 24 | 10.29753 | 10.04916 | 5 | 9.95084 | 15 |
| 46 | 25 52 | 34 8 | 65356 | 19 | 34644 | 70278 | 24 | 29722 | 04922 | 5 | 95078 | 14 |
| 47 | 25 44 | 34 16 | 65381 | 20 | 34619 | 70309 | 25 | 29691 | 04929 | 5 | 95071 | 13 |
| 48 | 25 36 | 34 24 | 65406 | 20 | 34594 | 70341 | 25 | 29659 | 04935 | 5 | 95065 | 12 |
| 49 | 25 28 | 34 32 | 65431 | 21 | 34569 | 70372 | 26 | 29628 | 04941 | 5 | 95059 | 11 |
| 50 | 8 25 20 | 3 34 40 | 9.65456 | 21 | 10.34544 | 9.70404 | 26 | 10.29596 | 10.04948 | 5 | 9.95052 | 10 |
| 51 | 25 12 | 34 48 | 65481 | 22 | 34519 | 70435 | 27 | 29565 | 04954 | 5 | 95046 | 9 |
| 52 | 25 4 | 34 56 | 65506 | 22 | 34494 | 70466 | 27 | 29534 | 04961 | 5 | 95039 | 8 |
| 53 | 24 56 | 35 4 | 65531 | 22 | 34469 | 70498 | 28 | 29502 | 04967 | 6 | 95033 | 7 |
| 54 | 24 48 | 35 12 | 65556 | 23 | 34444 | 70529 | 28 | 29471 | 04973 | 6 | 95027 | 6 |
| 55 | 8 24 40 | 3 35 20 | 9.65580 | 23 | 10.34420 | 9.70560 | 29 | 10.29440 | 10.04980 | 6 | 9.95020 | 5 |
| 56 | 24 32 | 35 28 | 65605 | 24 | 34395 | 70592 | 30 | 29408 | 04986 | 6 | 95014 | 4 |
| 57 | 24 24 | 35 36 | 65630 | 24 | 34370 | 70623 | 30 | 29377 | 04993 | 6 | 95007 | 3 |
| 58 | 24 16 | 35 44 | 65655 | 25 | 34345 | 70654 | 31 | 29346 | 04999 | 6 | 95001 | 2 |
| 59 | 24 8 | 35 52 | 65680 | 25 | 34320 | 70685 | 31 | 29315 | 05005 | 6 | 94995 | 1 |
| 60 | 24 0 | 36 0 | 65705 | 25 | 34295 | 70717 | 32 | 29283 | 05012 | 6 | 94988 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |

| 116° | | A | | A | B | B | C | | C | 63° |
|---|---|---|---|---|---|---|---|---|---|---|

| Seconds of time ....... | | 1 s | 2 s | 3 s | 4 s | 5 s | 6 s | 7 s |
|---|---|---|---|---|---|---|---|---|
| Prop. parts of cols. | A | 3 | 6 | 10 | 13 | 16 | 19 | 22 |
| | B | 4 | 8 | 12 | 16 | 20 | 24 | 28 |
| | C | 1 | 2 | 2 | 3 | 4 | 5 | 6 |

TABLE 44. [Page 635

## Log. Sines, Tangents, and Secants.

| 27° | | | A | | A | B | | B | C | | C | 152° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 8 24 0 | 3 36 0 | 9.65705 | 0 | 10.34295 | 9.70717¼ | 0 | 10.29283 | 10.05012 | 0 | 9.94988 | 60 |
| 1 | 23 52 | 36 8 | 65729 | 0 | 34271 | 70748 | 1 | 29252 | 05018 | 0 | 94982 | 59 |
| 2 | 23 44 | 36 16 | 65754 | 1 | 34246 | 70779 | 1 | 29221 | 05025 | 0 | 94975 | 58 |
| 3 | 23 36 | 36 24 | 65779 | 1· | 34221 | 70810 | 2 | 29190 | 05031 | 0 | 94969 | 57 |
| 4 | 23 28 | 36 32 | 65804 | 2 | 34196 | 70841 | 2 | 29159 | 05038 | 0 | 94962 | 56 |
| 5 | 8 23 20 | 3 36 40 | 9.65828 | 2 | 10.34172 | 9.70873 | 3 | 10.29127 | 10.05044 | 1 | 9.94956 | 55 |
| 6 | 23 12 | 36 48 | 65853 | 2 | 34147 | 70904 | 3 | 29096 | 05051 | 1 | 94949 | 54 |
| 7 | 23 4 | 36 56 | 65878 | 3 | 34122 | 70935 | 4 | 29065 | 05057 | 1 | 94943 | 53 |
| 8 | 22 56 | 37 4 | 65902 | 3 | 34098 | 70966 | 4 | 29034 | 05064 | 1 | 94936 | 52 |
| 9 | 22 48 | 37 12 | 65927 | 4 | 34073 | 70997 | 5 | 29003 | 05070 | 1 | 94930 | 51 |
| 10 | 8 22 40 | 3 37 20 | 9.65952 | 4 | 10.34048 | 9.71028 | 5 | 10.28972 | 10.05077 | 1 | 9.94923 | 50 |
| 11 | 22 32 | 37 28 | 65976 | 4 | 34024 | 71059 | 6 | 28941 | 05083 | 1 | 94917 | 49 |
| 12 | 22 24 | 37 36 | 66001 | 5 | 33999 | 71090 | 6 | 28910 | 05089 | 1 | 94911 | 48 |
| 13 | 22 16 | 37 44 | 66025 | 5 | 33975 | 71121 | 7 | 28879 | 05096 | 1 | 94904 | 47 |
| 14 | 22 8 | 37 52 | 66050 | 6 | 33950 | 71153 | 7 | 28847 | 05102 | 2 | 94898 | 46 |
| 15 | 8 22 0 | 3 38 0 | 9.66075 | 6 | 10.33925 | 9.71184 | 8 | 10.28816 | 10.05109 | 2 | 9.94891 | 45 |
| 16 | 21 52 | 38 8 | 66099 | 6 | 33901 | 71215 | 8 | 28785 | 05115 | 2 | 94885 | 44 |
| 17 | 21 44 | 38 16 | 66124 | 7 | 33876 | 71246 | 9 | 28754 | 05122 | 2 | 94878 | 43 |
| 18 | 21 36 | 38 24 | 66148 | 7 | 33852 | 71277 | 9 | 28723 | 05129 | 2 | 94871 | 42 |
| 19 | 21 28 | 38 32 | 66173 | 8 | 33827 | 71308 | 10 | 28692 | 05135 | 2 | 94865 | 41 |
| 20 | 8 21 20 | 3 38 40 | 9.66197 | 8 | 10.33803 | 9.71339 | 10 | 10.28661 | 10.05142 | 2 | 9.94858 | 40 |
| 21 | 21 12 | 38 48 | 66221 | 8 | 33779 | 71370 | 11 | 28630 | 05148 | 2 | 94852 | 39 |
| 22 | 21 4 | 38 56 | 66246 | 9 | 33754 | 71401 | 11 | 28599 | 05155 | 2 | 94845 | 38 |
| 23 | 20 56 | 39 4 | 66270 | 9 | 33730 | 71431 | 12 | 28569 | 05161 | 3 | 94839 | 37 |
| 24 | 20 48 | 39 12 | 66295 | 10 | 33705 | 71462 | 12 | 28538 | 05168 | 3 | 94832 | 36 |
| 25 | 8·20 40 | 3 39 20 | 9.66319 | 10 | 10.33681 | 9.71493 | 13 | 10.28507 | 10.05174 | 3 | 9.94826 | 35 |
| 26 | 20 32 | 39 28 | 66343 | 11 | 33657 | 71524 | 13 | 28476 | 05181 | 3 | 94819 | 34 |
| 27 | 20 24 | 39 36 | 66368 | 11 | 33632 | 71555 | 14 | 28445 | 05187 | 3 | 94813 | 33 |
| 28 | 20 16 | 39 44 | 66392 | 11 | 33608 | 71586 | 14 | 28414 | 05194 | 3 | 94806 | 32 |
| 29 | 20 8 | 39 52 | 66416 | 12 | 33584 | 71617 | 15 | 28383 | 05201 | 3 | 94799 | 31 |
| 30 | 8 20 0 | 3 40 0 | 9.66441 | 12 | 10.33559 | 9.71648 | 15 | 10.28352 | 10.05207 | 3 | 9.94793 | 30 |
| 31 | 19 52 | 40 8 | 66465 | 13 | 33535 | 71679 | 16 | 28321 | 05214 | 3 | 94786 | 29 |
| 32 | 19 44 | 40 16 | 66489 | 13 | 33511 | 71709 | 16 | 28291 | 05220 | 4 | 94780 | 28 |
| 33 | 19 36 | 40 24 | 66513 | 13 | 33487 | 71740 | 17 | 28260 | 05227 | 4 | 94773 | 27 |
| 34 | 19 28 | 40 32 | 66537 | 14 | 33463 | 71771 | 17 | 28229 | 05233 | 4 | 94767 | 26 |
| 35 | 8 19 20 | 3 40 40 | 9.66562 | 14 | 10.33438 | 9.71802 | 18 | 10.28198 | 10.05240 | 4 | 9.94760 | 25 |
| 36 | 19 12 | 40 48 | 66586 | 15 | 33414 | 71833 | 19 | 28167 | 05247 | 4 | 94753 | 24 |
| 37 | 19 4 | 40 56 | 66610 | 15 | 33390 | 71863 | 19 | 28137 | 05253 | 4 | 94747 | 23 |
| 38 | 18 56 | 41 4 | 66634 | 15 | 33366 | 71894 | 20 | 28106 | 05260 | 4 | 94740 | 22 |
| 39 | 18 48 | 41 12 | 66658 | 16 | 33342 | 71925 | 20 | 28075 | 05266 | 4 | 94734 | 21 |
| 40 | 8 18 40 | 3 41 20 | 9.66682 | 16 | 10.33318 | 9.71955 | 21 | 10.28045 | 10.05273 | 4 | 9.94727 | 20 |
| 41 | 18 32 | 41 28 | 66706 | 17 | 33294 | 71986 | 21 | 28014 | 05280 | 4 | 94720 | 19 |
| 42 | 18 24 | 41 36 | 66731 | 17 | 33269 | 72017 | 22 | 27983 | 05286 | 5 | 94714 | 18 |
| 43 | 18 16 | 41 44 | 66755 | 17 | 33245 | 72048 | 22 | 27952 | 05293 | 5 | 94707 | 17 |
| 44 | 18 8 | 41 52 | 66779 | 18 | 33221 | 72078 | 23 | 27922 | 05300 | 5 | 94700 | 16 |
| 45 | 8 18 0 | 3 42 0 | 9.66803 | 18 | 10.33197 | 9.72109 | 23 | 10.27891 | 10.05306 | 5 | 9.94694 | 15 |
| 46 | 17 52 | 42 8 | 66827 | 19 | 33173 | 72140 | 24 | 27860 | 05313 | 5 | 94687 | 14 |
| 47 | 17 44 | 42 16 | 66851 | 19 | 33149 | 72170 | 24 | 27830 | 05320 | 5 | 94680 | 13 |
| 48 | 17 36 | 42 24 | 66875 | 19 | 33125 | 72201 | 25 | 27799 | 05326 | 5 | 94674 | 12 |
| 49 | 17 28 | 42 32 | 66899 | 20 | 33101 | 72231 | 25 | 27769 | 05333 | 5 | 94667 | 11 |
| 50 | 8 17 20 | 3 42 40 | 9.66922 | 20 | 10.33078 | 9.72262 | 26 | 10.27738 | 10.05340 | 5 | 9.94660 | 10 |
| 51 | 17 12 | 42 48 | 66946 | 21 | 33054 | 72293 | 26 | 27707 | 05346 | 6 | 94654 | 9 |
| 52 | 17 4 | 42 56 | 66970 | 21 | 33030 | 72323 | 27 | 27677 | 05353 | 6 | 94647 | 8 |
| 53 | 16 56 | 43 4 | 66994 | 21 | 33006 | 72354 | 27 | 27646 | 05360 | 6 | 94640 | 7 |
| 54 | 16 48 | 43 12 | 67018 | 22 | 32982 | 72384 | 28 | 27616 | 05366 | 6 | 94634 | 6 |
| 55 | 8 16 40 | 3 43 20 | 9.67042 | 22 | 10.32958 | 9.72415 | 28 | 10.27585 | 10.05373 | 6 | 9.94627 | 5 |
| 56 | 16 32 | 43 28 | 67066 | 23 | 32934 | 72445 | 29 | 27555 | 05380 | 6 | 94620 | 4 |
| 57 | 16 24 | 43 36 | 67090 | 23 | 32910 | 72476 | 29 | 27524 | 05386 | 6 | 94614 | 3 |
| 58 | 16 16 | 43 44 | 67113 | 23 | 32887 | 72506 | 30 | 27494 | 05393 | 6 | 94607 | 2 |
| 59 | 16 8 | 43 52 | 67137 | 24 | 32863 | 72537 | 30 | 27463 | 05400 | 6 | 94600 | 1 |
| 60 | 16 0 | 44 0 | 67161 | 24 | 32839 | 72567 | 31 | 27433 | 05407 | 7 | 94593 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 117° | | | A | | A | B | | B | C | | C | 62° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 3 | 6 | 9 | 12 | 15 | 18 | 21 |
| B | 4 | 8 | 12 | 15 | 19 | 23 | 27 |
| C | 1 | 2 | 2 | 3 | 4 | 5 | 6 |

# TABLE 44.

Log. Sines, Tangents, and Secants.

| 28° | | | A | | A | B | | B | C | | C | 151° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 8 16 0 | 3 44 0 | 9. 67161 | 0 | 10. 32839 | 9. 72567 | 0 | 10. 27433 | 10. 05407 | 0 | 9. 94593 | 60 |
| 1 | 15 52 | 44 8 | 67185 | 0 | 32815 | 72598 | 1 | 27402 | 05413 | 0 | 94587 | 59 |
| 2 | 15 44 | 44 16 | 67208 | 1 | 32792 | 72628 | 1 | 27372 | 05420 | 0 | 94580 | 58 |
| 3 | 15 36 | 44 24 | 67232 | 1 | 32768 | 72659 | 2 | 27341 | 05427 | 0 | 94573 | 57 |
| 4 | 15 28 | 44 32 | 67256 | 2 | 32744 | 72689 | 2 | 27311 | 05433 | 0 | 94567 | 56 |
| 5 | 8 15 20 | 3 44 40 | 9. 67280 | 2 | 10. 32720 | 9. 72720 | 3 | 10. 27280 | 10. 05440 | 1 | 9. 94560 | 55 |
| 6 | 15 12 | 44 48 | 67303 | 2 | 32697 | 72750 | 3 | 27250 | 05447 | 1 | 94553 | 54 |
| 7 | 15 4 | 44 56 | 67327 | 3 | 32673 | 72780 | 4 | 27220 | 05454 | 1 | 94546 | 53 |
| 8 | 14 56 | 45 4 | 67350 | 3 | 32650 | 72811 | 4 | 27189 | 05460 | 1 | 94540 | 52 |
| 9 | 14 48 | 45 12 | 67374 | 3 | 32626 | 72841 | 5 | 27159 | 05467 | 1 | 94533 | 51 |
| 10 | 8 14 40 | 3 45 20 | 9. 67398 | 4 | 10. 32602 | 9. 72872 | 5 | 10. 27128 | 10. 05474 | 1 | 9. 94526 | 50 |
| 11 | 14 32 | 45 28 | 67421 | 4 | 32579 | 72902 | 6 | 27098 | 05481 | 1 | 94519 | 49 |
| 12 | 14 24 | 45 36 | 67445 | 5 | 32555 | 72932 | 6 | 27068 | 05487 | 1 | 94513 | 48 |
| 13 | 14 16 | 45 44 | 67468 | 5 | 32532 | 72963 | 7 | 27037 | 05494 | 1 | 94506 | 47 |
| 14 | 14 8 | 45 52 | 67492 | 5 | 32508 | 72993 | 7 | 27007 | 05501 | 2 | 94499 | 46 |
| 15 | 8 14 0 | 3 46 0 | 9. 67515 | ·6 | 10. 32485 | 9. 73023 | 8 | 10. 26977 | 10. 05508 | 2 | 9. 94492 | 45 |
| 16 | 13 52 | 46 8 | 67539 | 6 | 32461 | 73054 | 8 | 26946 | 05515 | 2 | 94485 | 44 |
| 17 | 13 44 | 46 16 | 67562 | 7 | 32438 | 73084 | 9 | 26916 | 05521 | 2 | 94479 | 43 |
| 18 | 13 36 | 46 24 | 67586 | 7 | 32414 | 73114 | 9 | 26886 | 05528 | 2 | 94472 | 42 |
| 19 | 13 28 | 46 32 | 67609 | 7 | 32391 | 73144 | 10 | 26856 | 05535 | 2 | 94465 | 41 |
| 20 | 8 13 20 | 3 46 40 | 9. 67633 | 8 | 10. 32367 | 9. 73175 | 10 | 10. 26825 | 10. 05542 | 2 | 9. 94458 | 40 |
| 21 | 13 12 | 46 48 | 67656 | 8 | 32344 | 73205 | 11 | 26795 | 05549 | 2 | 94451 | 39 |
| 22 | 13 4 | 46 56 | 67680 | 9 | 32320 | 73235 | 11 | 26765 | 05555 | 3 | 94445 | 38 |
| 23 | 12 56 | 47 4 | 67703 | 9 | 32297 | 73265 | 12 | 26735 | 05562 | 3 | 94438 | 37 |
| 24 | 12 48 | 47 12 | 67726 | 9 | 32274 | 73295 | 12 | 26705 | 05569 | 3 | 94431 | 36 |
| 25 | 8 12 40 | 3 47 20 | 9. 67750 | 10 | 10. 32250 | 9. 73326 | 13 | 10. 26674 | 10. 05576 | 3 | 9. 94424 | 35 |
| 26 | 12 32 | 47 28 | 67773 | 10 | 32227 | 73356 | 13 | 26644 | 05583 | 3 | 94417 | 34 |
| 27 | 12 24 | 47 36 | 67796 | 10 | 32204 | 73386 | 14 | 26614 | 05590 | 3 | 94410 | 33 |
| 28 | 12 16 | 47 44 | 67820 | 11 | 32180 | 73416 | 14 | 26584 | 05596 | 3 | 94404 | 32 |
| 29 | 12 8 | 47 52 | 67843 | 11 | 32157 | 73446 | 15 | 26554 | 05603 | 3 | 94397 | 31 |
| 30 | 8 12 0 | 3 48 0 | 9. 67866 | 12 | 10. 32134 | 9. 73476 | 15 | 10. 26524 | 10. 05610 | 3 | 9. 94390 | 30 |
| 31 | 11 52 | 48 8 | 67890 | 12 | 32110 | 73507 | 16 | 26493 | 05617 | 4 | 94383 | 29 |
| 32 | 11 44 | 48 16 | 67913 | 12 | 32087 | 73537 | 16 | 26463 | 05624 | 4 | 94376 | 28 |
| 33 | 11 36 | 48 24 | 67936 | 13 | 32064 | 73567 | 17 | 26433 | 05631 | 4 | 94369 | 27 |
| 34 | 11 28 | 48 32 | 67959 | 13 | 32041 | 73597 | 17 | 26403 | 05638 | 4 | 94362 | 26 |
| 35 | 8 11 20 | 3 48 40 | 9. 67982 | 14 | 10. 32018 | 9. 73627 | 18 | 10. 26373 | 10. 05645 | 4 | 9. 94355 | 25 |
| 36 | 11 12 | 48 48 | 68006 | 14 | 31994 | 73657 | 18 | 26343 | 05651 | 4 | 94349 | 24 |
| 37 | 11 4 | 48 56 | 68029 | 14 | 31971 | 73687 | 19 | 26313 | 05658 | 4 | 94342 | 23 |
| 38 | 10 56 | 49 4 | 68052 | 15 | 31948 | 73717 | 19 | 26283 | 05665 | 4 | 94335 | 22 |
| 39 | 10 48 | 49 12 | 68075 | 15 | 31925 | 73747 | 20 | 26253 | 05672 | 4 | 94328 | 21 |
| 40 | 8 10 40 | 3 49 20 | 9. 68098 | 16 | 10. 31902 | 9. 73777 | 20 | 10. 26223 | 10. 05679 | 5 | 9. 94321 | 20 |
| 41 | 10 32 | 49 28 | 68121 | 16 | 31879 | 73807 | 21 | 26193 | 05686 | 5 | 94314 | 19 |
| 42 | 10 24 | 49 36 | 68144 | 16 | 31856 | 73837 | 21 | 26163 | 05693 | 5 | 94307 | 18 |
| 43 | 10 16 | 49 44 | 68167 | 17 | 31833 | 73867 | 22 | 26133 | 05700 | 5 | 94300 | 17 |
| 44 | 10 8 | 49 52 | 68190 | 17 | 31810 | 73897 | 22 | 26103 | 05707 | 5 | 94293 | 16 |
| 45 | 8 10 0 | 3 50 0 | 9. 68213 | 17 | 10. 31787 | 9. 73927 | 23 | 10. 26073 | 10. 05714 | 5 | 9. 94286 | 15 |
| 46 | 9 52 | 50 8 | 68237 | 18 | 31763 | 73957 | 23 | 26043 | 05721 | 5 | 94279 | 14 |
| 47 | 9 44 | 50 16 | 68260 | 18 | 31740 | 73987 | 24 | 26013 | 05727 | 5 | 94273 | 13 |
| 48 | 9 36 | 50 24 | 68283 | 19 | 31717 | 74017 | 24 | 25983 | 05734 | 5 | 94266 | 12 |
| 49 | 9 28 | 50 32 | 68305 | 19 | 31695 | 74047 | 25 | 25953 | 05741 | 6 | 94259 | 11 |
| 50 | 8 9 20 | 3 50 40 | 9. 68328 | 19 | 10. 31672 | 9. 74077 | 25 | 10. 25923 | 10. 05748 | 6 | 9. 94252 | 10 |
| 51 | 9 12 | 50 48 | 68351 | 20 | 31649 | 74107 | 26 | 25893 | 05755 | 6 | 94245 | 9 |
| 52 | 9 4 | 50 56 | 68374 | 20 | 31626 | 74137 | 26 | 25863 | 05762 | 6 | 94238 | 8 |
| 53 | 8 56 | 51 4 | 68397 | 21 | 31603 | 74166 | 27 | 25834 | 05769 | 6 | 94231 | 7 |
| 54 | 8 48 | 51 12 | 68420 | 21 | 31580 | 74196 | 27 | 25804 | 05776 | 6 | 94224 | 6 |
| 55 | 8 8 40 | 3 51 20 | 9. 68443 | 21 | 10. 31557 | 9. 74226 | 28 | 10. 25774 | 10. 05783 | 6 | 9. 94217 | 5 |
| 56 | 8 32 | 51 28 | 68466 | 22 | 31534 | 74256 | 28 | 25744 | 05790 | 6 | 94210 | 4 |
| 57 | 8 24 | 51 36 | 68489 | 22 | 31511 | 74286 | 29 | 25714 | 05797 | 7 | 94203 | 3 |
| 58 | 8 16 | 51 44 | 68512 | 22 | 31488 | 74316 | 29 | 25684 | 05804 | 7 | 94196 | 2 |
| 59 | 8 8 | 51 52 | 68534 | 23 | 31466 | 74345 | 30 | 25655 | 05811 | 7 | 94189 | 1 |
| 60 | 8 0 | 52 0 | 68557 | 23 | 31443 | 74375 | 30 | 25625 | 05818 | 7 | 94182 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M |
| 118° | | | A | | A | B | | B | C | | C | 61° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 3 | 6 | 9 | 12 | 15 | 17 | 20 |
| B | 4 | 8 | 11 | 15 | 19 | 23 | 26 |
| C | 1 | 2 | 3 | 3 | 4 | 5 | 6 |

TABLE 44. [Page 637

## Log. Sines, Tangents, and Secants.

| 29° | | | A | | A | B | | B | C | | C | 150° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 8 8 0 | 3 52 0 | 9.68557 | 0 | 10.31443 | 9.74375 | 0 | 10.25625 | 10.05818 | 0 | 9.94182 | 60 |
| 1 | 7 52 | 52 8 | 68580 | 0 | 31420 | 74405 | 0 | 25595 | 05825 | 0 | 94175 | 59 |
| 2 | 7 44 | 52 16 | 68603 | 1 | 31397 | 74435 | 1 | 25565 | 05832 | 0 | 94168 | 58 |
| 3 | 7 36 | 52 24 | 68625 | 1 | 31375 | 74465 | 1 | 25535 | 05839 | 0 | 94161 | 57 |
| 4 | 7 28 | 52 32 | 68648 | 1 | 31352 | 74494 | 2 | 25506 | 05846 | 0 | 94154 | 56 |
| 5 | 8 7 20 | 3 52 40 | 9.68671 | 2 | 10.31329 | 9.74524 | 2 | 10.25476 | 10.05853 | 1 | 9.94147 | 55 |
| 6 | 7 12 | 52 48 | 68694 | 2 | 31306 | 74554 | 3 | 25446 | 05860 | 1 | 94140 | 54 |
| 7 | 7 4 | 52 56 | 68716 | 3 | 31284 | 74583 | 3 | 25417 | 05867 | 1 | 94133 | 53 |
| 8 | 6 56 | 53 4 | 68739 | 3 | 31261 | 74613 | 4 | 25387 | 05874 | 1 | 94126 | 52 |
| 9 | 6 48 | 53 12 | 68762 | 3 | 31238 | 74643 | 4 | 25357 | 05881 | 1 | 94119 | 51 |
| 10 | 8 6 40 | 3 53 20 | 9.68784 | 4 | 10.31216 | 9.74673 | 5 | 10.25327 | 10.05888 | 1 | 9.94112 | 50 |
| 11 | 6 32 | 53 28 | 68807 | 4 | 31193 | 74702 | 5 | 25298 | 05895 | 1 | 94105 | 49 |
| 12 | 6 24 | 53 36 | 68829 | 4 | 31171 | 74732 | 6 | 25268 | 05902 | 1 | 94098 | 48 |
| 13 | 6 16 | 53 44 | 68852 | 5 | 31148 | 74762 | 6 | 25238 | 05910 | 2 | 94090 | 47 |
| 14 | 6 8 | 53 52 | 68875 | 5 | 31125 | 74791 | 7 | 25209 | 05917 | 2 | 94083 | 46 |
| 15 | 8 6 0 | 3 54 0 | 9.68897 | 6 | 10.31103 | 9.74821 | 7 | 10.25179 | 10.05924 | 2 | 9.94076 | 45 |
| 16 | 5 52 | 54 8 | 68920 | 6 | 31080 | 74851 | 8 | 25149 | 05931 | 2 | 94069 | 44 |
| 17 | 5 44 | 54 16 | 68942 | 6 | 31058 | 74880 | 8 | 25120 | 05938 | 2 | 94062 | 43 |
| 18 | 5 36 | 54 24 | 68965 | 7 | 31035 | 74910 | 9 | 25090 | 05945 | 2 | 94055 | 42 |
| 19 | 5 28 | 54 32 | 68987 | 7 | 31013 | 74939 | 9 | 25061 | 05952 | 2 | 94048 | 41 |
| 20 | 8 5 20 | 3 54 40 | 9.69010 | 7 | 10.30990 | 9.74969 | 10 | 10.25031 | 10.05959 | 2 | 9.94041 | 40 |
| 21 | 5 12 | 54 48 | 69032 | 8 | 30968 | 74998 | 10 | 25002 | 05966 | 3 | 94034 | 39 |
| 22 | 5 4 | 54 56 | 69055 | 8 | 30945 | 75028 | 11 | 24972 | 05973 | 3 | 94027 | 38 |
| 23 | 4 56 | 55 4 | 69077 | 9 | 30923 | 75058 | 11 | 24942 | 05980 | 3 | 94020 | 37 |
| 24 | 4 48 | 55 12 | 69100 | 9 | 30900 | 75087 | 12 | 24913 | 05988 | 3 | 94012 | 36 |
| 25 | 8 4 40 | 3 55 20 | 9.69122 | 9 | 10.30878 | 9.75117 | 12 | 10.24883 | 10.05995 | 3 | 9.94005 | 35 |
| 26 | 4 32 | 55 28 | 69144 | 10 | 30856 | 75146 | 13 | 24854 | 06002 | 3 | 93998 | 34 |
| 27 | 4 24 | 55 36 | 69167 | 10 | 30833 | 75176 | 13 | 24824 | 06009 | 3 | 93991 | 33 |
| 28 | 4 16 | 55 44 | 69189 | 10 | 30811 | 75205 | 14 | 24795 | 06016 | 3 | 93984 | 32 |
| 29 | 4 8 | 55 52 | 69212 | 11 | 30788 | 75235 | 14 | 24765 | 06023 | 3 | 93977 | 31 |
| 30 | 8 4 0 | 3 56 0 | 9.69234 | 11 | 10.30766 | 9.75264 | 15 | 10.24736 | 10.06030 | 4 | 9.93970 | 30 |
| 31 | 3 52 | 56 8 | 69256 | 12 | 30744 | 75294 | 15 | 24706 | 06037 | 4 | 93963 | 29 |
| 32 | 3 44 | 56 16 | 69279 | 12 | 30721 | 75323 | 16 | 24677 | 06045 | 4 | 93955 | 28 |
| 33 | 3 36 | 56 24 | 69301 | 12 | 30699 | 75353 | 16 | 24647 | 06052 | 4 | 93948 | 27 |
| 34 | 3 28 | .56 32 | 69323 | 13 | 30677 | 75382 | 17 | 24618 | 06059 | 4 | 93941 | 26 |
| 35 | 8 3 20 | 3 56 40 | 9.69345 | 13 | 10.30655 | 9.75411 | 17 | 10.24589 | 10.06066 | 4 | 9.93934 | 25 |
| 36 | 3 12 | 56 48 | 69368 | 13 | 30632 | 75441 | 18 | 24559 | 06073 | 4 | 93927 | 24 |
| 37 | 3 4 | 56 56 | 69390 | 14 | 30610 | 75470 | 18 | 24530 | 06080 | 4 | 93920 | 23 |
| 38 | 2 56 | 57 4 | 69412 | 14 | 30588 | 75500 | 19 | 24500 | 06088 | 5 | 93912 | 22 |
| 39 | 2·48 | 57 12 | 69434 | 15 | 30566 | 75529 | 19 | 24471 | 06095 | 5 | 93905 | 21 |
| 40 | 8 2 40 | 3 57 20 | 9.69456 | 15 | 10.30544 | 9.75558 | 20 | 10.24442 | 10.06102 | 5 | 9.93898 | 20 |
| 41 | 2 32 | 57 28 | 69479 | 15 | 30521 | 75588 | 20 | 24412 | 06109 | 5 | 93891 | 19 |
| 42 | 2 24 | 57 36 | 69501 | 16 | 30499 | 75617 | 21 | 24383 | 06116 | 5 | 93884 | 18 |
| 43 | 2 16 | 57 44 | 69523 | 16 | 30477 | 75647 | 21 | 24353 | 06124 | 5 | 93876 | 17 |
| 44 | 2 8 | 57 52 | 69545 | 16 | 30455 | 75676 | 22 | 24324 | 06131 | 5 | 93869 | 16 |
| 45 | 8 2 0 | 3 58 0 | 9.69567 | 17 | 10.30433 | 9.75705 | 22 | 10.24295 | 10.06138 | 5 | 9.93862 | 15 |
| 46 | 1 52 | 58 8 | 69589 | 17 | 30411 | 75735 | 23 | 24265 | 06145 | 5 | 93855 | 14 |
| 47 | 1 44 | 58 16 | 69611 | 17 | 30389 | 75764 | 23 | 24236 | 06153 | 6 | 93847 | 13 |
| 48 | 1 36 | 58 24 | 69633 | 18 | 30367 | 75793 | 24 | 24207 | 06160 | 6 | 93840 | 12 |
| 49 | 1 28 | 58 32 | 69655 | 18 | 30345 | 75822 | 24 | 24178 | 06167 | 6 | 93833 | 11 |
| 50 | 8 1 20 | 3 58 40 | 9.69677 | 19 | 10.30323 | 9.75852 | 25 | 10.24148 | 10.06174 | 6 | 9.93826 | 10 |
| 51 | 1 12 | 58 48 | 69699 | 19 | 30301 | 75881 | 25 | 24119 | 06181 | 6 | 93819 | 9 |
| 52 | 1 4 | 58 56 | 69721 | 19 | 30279 | 75910 | 26 | 24090 | 06189 | 6 | 93811 | 8 |
| 53 | 0 56 | 59 4 | 69743 | 20 | 30257 | 75939 | 26 | 24061 | 06196 | 6 | 93804 | 7 |
| 54 | 0 48 | 59 12 | 69765 | 20 | 30235 | 75969 | 27 | 24031 | 06203 | 6 | 93797 | 6 |
| 55 | 8 0 40 | 3 59 20 | 9.69787 | 20 | 10.30213 | 9.75998 | 27 | 10.24002 | 10.06211 | 7 | 9.93789 | 5 |
| 56 | 0 32 | 59 28 | 69809 | 21 | 30191 | 76027 | 28 | 23973 | 06218 | 7 | 93782 | 4 |
| 57 | 0 24 | . 59 36 | 69831 | 21 | 30169 | 76056 | 28 | 23944 | 06225 | 7 | 93775 | 3 |
| 58 | ·0 16 | 59 44 | 69853 | 22 | 30147 | 76086 | 29 | 23914 | 06232 | 7 | 93768 | 2 |
| 59 | 0 8 | 59 52 | 69875 | 22 | 30125 | 76115 | 29 | 23885 | 06240 | 7 | 93760 | 1 |
| 60 | 0 0 | 4 0 0 | 69897 | 22 | 30103 | 76144 | 29 | 23856 | 06247 | 7 | 93753 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 119° | | | A | | A | B | | B | C | | C | 60° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 3 | 6 | 8 | 11 | 14 | 17 | 20 |
| B | 4 | 7 | 11 | 15 | 18 | 22 | 26 |
| C | 1 | 2 | 3 | 4 | 4 | 5 | 6 |

## TABLE 44.

### Log. Sines, Tangents, and Secants.

| 30° | | | | A | | A | B | | B | C | | C | 149° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 8 0 0 | 4 0 0 | | 9. 69897 | 0 | 10. 30103 | 9. 76144 | 0 | 10. 23856 | 10. 06247 | 0 | 9. 93753 | 60 |
| 1 | 7 59 52 | 0 8 | | 69919 | 0 | 30081 | 76173 | 0 | 23827 | 06254 | 0 | 93746 | 59 |
| 2 | 59 44 | 0 16 | | 69941 | 1 | 30059 | 76202 | 1 | 23798 | 06262 | 0 | 93738 | 58 |
| 3 | 59 36 | 0 24 | | 69963 | 1 | 30037 | 76231 | 1 | 23769 | 06269 | 0 | 93731 | 57 |
| 4 | 59 28 | 0 32 | | 69984 | 1 | 30016 | 76261 | 2 | 23739 | 06276 | 0 | 93724 | 56 |
| 5 | 7 59 20 | 4 0 40 | | 9. 70006 | 2 | 10. 29994 | 9. 76290 | 2 | 10. 23710 | 10. 06283 | 1 | 9. 93717 | 55 |
| 6 | 59 12 | 0 48 | | 70028 | 2 | 29972 | 76319 | 3 | 23681 | 06291 | 1 | 93709 | 54 |
| 7 | 59 4 | 0 56 | | 70050 | 3 | 29950 | 76348 | 3 | 23652 | · 06298 | 1 | 93702 | 53 |
| 8 | 58 56 | 1 4 | | 70072 | 3 | 29928 | 76377 | 4 | 23623 | 06305 | 1 | 93695 | 52 |
| 9 | 58 48 | 1 12 | | 70093 | 3 | 29907 | 76406 | 4 | 23594 | 06313 | 1 | 93687 | 51 |
| 10 | 7 58 40 | 4 1 20 | | 9. 70115 | 4 | 10. 29885 | 9. 76435 | 5 | 10. 23565 | 10. 06320 | 1 | 9. 93680 | 50 |
| 11 | 58 32 | 1 28 | | 70137 | 4 | 29863 | 76464 | 5 | 23536 | 06327 | 1 | 93673 | 49 |
| 12 | 58 24 | 1 36 | | 70159 | 4 | 29841 | 76493 | 6 | 23507 | 06335 | 1 | 93665 | 48 |
| 13 | 58 16 | 1 44 | | 70180 | 5 | 29820 | 76522 | 6 | 23478 | 06342 | 2 | 93658 | 47 |
| 14 | 58 8 | 1 52 | | 70202 | 5 | 29798 | 76551 | 7 | 23449 | 06350 | 2 | 93650 | 46 |
| 15 | 7 58 0 | 4 2 0 | | 9. 70224 | 5 | 10. 29776 | 9. 76580 | 7 | 10. 23420 | 10. 06357 | 2 | 9. 93643 | 45 |
| 16 | 57 52 | 2 8 | | 70245 | 6 | 29755 | 76609 | 8 | 23391 | 06364 | 2 | 93636 | 44 |
| 17 | 57 44 | 2 16 | | 70267 | 6 | 29733 | 76639 | 8 | 23361 | 06372 | 2 | 93628 | 43 |
| 18 | 57 36 | 2 24 | | 70288 | 6 | 29712 | 76668 | 9 | 23332 | 06379 | 2 | 93621 | 42 |
| 19 | 57 28 | 2 32 | | 70310 | 7 | 29690 | 76697 | 9 | 23303 | 06386 | 2 | 93614 | 41 |
| 20 | 7 57 20 | 4 2 40 | | 9. 70332 | 7 | 10. 29668 | 9. 76725 | 10 | 10. 23275 | 10. 06394 | 2 | 9. 93606 | 40 |
| 21 | 57 12 | 2 48 | | 70353 | 8 | 29647 | 76754 | 10 | 23246 | 06401 | 3 | 93599 | 39 |
| 22 | 57 4 | 2 56 | | 70375 | 8 | 29625 | 76783 | 11 | 23217 | 06409 | 3 | 93591 | 38 |
| 23 | 56 56 | 3 4 | | 70396 | 8 | 29604 | 76812 | 11 | 23188 | 06416 | 3 | 93584 | 37 |
| 24 | 56 48 | 3 12 | | 70418 | 9 | 29582 | 76841 | 12 | 23159 | 06423 | 3 | 93577 | 36 |
| 25 | 7 56 40 | 4 3 20 | | 9. 70439 | 9 | 10. 29561 | 9. 76870 | 12 | 10. 23130 | 10. 06431 | 3 | 9. 93569 | 35 |
| 26 | 56 32 | 3 28 | | 70461 | 9 | 29539 | 76899 | 13 | 23101 | 06438 | 3 | 93562 | 34 |
| 27 | 56 24 | 3 36 | | 70482 | 10 | 29518 | 76928 | 13 | 23072 | 06446 | 3 | 93554 | 33 |
| 28 | 56 16 | 3 44 | | 70504 | 10 | 29496 | 76957 | 13 | 23043 | 06453 | 3 | 93547 | 32 |
| 29 | 56 8 | 3 52 | | 70525 | 10 | 29475 | 76986 | 14 | 23014 | 06461 | 4 | 93539 | 31 |
| 30 | 7 56 0 | 4 4 0 | | 9. 70547 | 11 | 10. 29453 | 9. 77015 | 14 | 10. 22985 | 10. 06468 | 4 | 9. 93532 | 30 |
| 31 | 55 52 | 4 8 | | 70568 | 11 | 29432 | 77044 | 15 | 22956 | 06475 | 4 | 93525 | 29 |
| 32 | 55 44 | 4 16 | | 70590 | 11 | 29410 | 77073 | 15 | 22927 | 06483 | 4 | 93517 | 28 |
| 33 | 55 36 | 4 24 | | 70611 | 12 | 29389 | 77101 | 16 | 22899 | 06490 | 4 | 93510 | 27 |
| 34 | 55 28 | 4 32 | | 70633 | 12 | 29367 | 77130 | 16 | 22870 | 06498 | .4 | 93502 | 26 |
| 35 | 7 55 20 | 4 4 40 | | 9. 70654 | 13 | 10. 29346 | 9. 77159 | 17 | 10. 22841 | 10. 06505 | 4 | 9. 93495 | 25 |
| 36 | 55 12 | 4 48 | | 70675 | 13 | 29325 | 77188 | 17 | 22812 | 06513 | 4 | 93487 | 24 |
| 37 | 55 4 | 4 56 | | 70697 | 13 | 29303 | 77217 | 18 | 22783 | 06520 | 5 | 93480 | 23 |
| 38 | 54 56 | 5 4 | | 70718 | 14 | 29282 | 77246 | 18 | 22754 | 06528 | 5 | 93472 | 22 |
| 39 | 54 48 | 5 12 | | 70739 | 14 | 29261 | 77274 | 19 | 22726 | 06535 | 5 | 93465 | 21 |
| 40 | 7 54 40 | 4 5 20 | | 9. 70761 | 14 | 10. 29239 | 9. 77303 | 19 | 10. 22697 | 10. 06543 | 5 | 9. 93457 | 20 |
| 41 | 54 32 | 5 28 | | 70782 | 15 | 29218 | 77332 | 20 | 22668 | 06550 | 5 | 93450 | 19 |
| 42 | 54 24 | 5 36 | | 70803 | 15 | 29197 | 77361 | 20 | 22639 | 06558 | 5 | 93442 | 18 |
| 43 | 54 16 | 5 44 | | 70824 | 15 | 29176 | 77390 | 21 | 22610 | 06565 | 5 | 93435 | 17 |
| 44 | 54 8 | 5 52 | | 70846 | 16 | 29154 | 77418 | 21 | 22582 | 06573 | 5 | 93427 | 16 |
| 45 | 7 54 0 | 4 6 0 | | 9. 70867 | 16 | 10. 29133 | 9. 77447 | 22 | 10. 22553 | 10. 06580 | 6 | 9. 93420 | 15 |
| 46 | 53 52 | 6 8 | | 70888 | 16 | 29112 | 77476 | 22 | 22524 | 06588 | 6 | 93412 | 14 |
| 47 | 53 44 | 6 16 | | 70909 | 17 | 29091 | 77505 | 23 | 22495 | 06595 | 6 | 93405 | 13 |
| 48 | 53 36 | 6 24 | | 70931 | 17 | 29069 | 77533 | 23 | 22467 | 06603 | 6 | 93397 | 12 |
| 49 | 53 28 | 6 32 | | 70952 | 17 | 29048 | 77562 | 24 | 22438 | 06610 | 6 | 93390 | 11 |
| 50 | 7 53 20 | 4 6 40 | | 9. 70973 | 18 | 10. 29027 | 9. 77591 | 24 | 10. 22409 | 10. 06618 | 6 | 9. 93382 | 10 |
| 51 | 53 12 | 6 48 | | 70994 | 18 | 29006 | 77619 | 25 | 22381 | 06625 | 6 | 93375 | 9 |
| 52 | 53 4 | 6 56 | | 71015 | 19 | 28985 | 77648 | 25 | 22352 | 06633 | 6 | 93367 | 8 |
| 53 | 52 56 | 7 4 | | 71036 | 19 | 28964 | 77677 | 26 | 22323 | 06640 | 7 | 93360 | 7 |
| 54 | 52 48 | 7 12 | | 71058 | 19 | 28942 | 77706 | 26 | 22294 | 06648 | 7 | 93352 | 6 |
| 55 | 7 52 40 | 4 7 20 | | 9. 71079 | 20 | 10. 28921 | 9. 77734 | 26 | 10. 22266 | 10. 06656 | 7 | 9. 93344 | 5 |
| 56 | 52 32 | 7 28 | | 71100 | 20 | 28900 | 77763 | 27 | 22237 | 06663 | 7 | 93337 | 4 |
| 57 | 52 24 | 7 36 | | 71121 | 20 | 28879 | 77791 | 27 | 22209 | 06671 | 7 | 93329 | 3 |
| 58 | 52 16 | 7 44 | | 71142 | 21 | 28858 | 77820 | 28 | 22180 | 06678 | 7 | 93322 | 2 |
| 59 | 52 8 | 7 52 | | 71163 | 21 | 28837 | 77849 | 28 | 22151 | 06686 | 7 | 93314 | 1 |
| 60 | 52 0 | 8 0 | | 71184 | 21 | 28816 | 77877 | 29 | 22123 | 06693 | 7 | 93307 | 0 |
| M. | Hour P. M | Hour A. M. | | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 120° | | | | A | | A | B | | B | . C | | C | 59° |

| Seconds of time ------ | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 3 | 5 | 8 | 11 | 13 | 16 | 19 |
| B | 4 | 7 | 11 | 14 | 18 | 22 | 25 |
| . C | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

TABLE 44. [Page 639

Log. Sines, Tangents, and Secants.

| 31° | | | A | | A | B | | B | C | | C | 148° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 7 52 0 | 4 8 0 | 9. 71184 | 0 | 10. 28816 | 9. 77877 | 0 | 10. 22123 | 10. 06693 | 0 | 9. 93307 | 60 |
| 1 | 51 52 | 8 8 | 71205 | 0 | 28795 | 77906 | 0 | 22094 | 06701 | 0 | 93299 | 59 |
| 2 | 51 44 | 8 16 | 71226 | 1 | 28774 | 77935 | 1 | 22065 | 06709 | 0 | 93291 | 58 |
| 3 | 51 36 | 8 24 | 71247 | 1 | 28753 | 77963 | 1 | 22037 | 06716 | 0 | 93284 | 57 |
| 4 | 51 28 | 8 32 | 71268 | 1 | 28732 | 77992 | 2 | 22008 | 06724 | 1 | 93276 | 56 |
| 5 | 7 51 20 | 4 8 40 | 9. 71289 | 2 | 10. 28711 | 9. 78020 | 2 | 10. 21980 | 10. 06731 | 1 | 9. 93269 | 55 |
| 6 | 51 12 | 8 48 | 71310 | 2 | 28690 | 78049 | 3 | 21951 | 06739 | 1 | 93261 | 54 |
| 7 | 51 4 | 8 56 | 71331 | 2 | 28669 | 78077 | 3 | 21923 | 06747 | 1 | 93253 | 53 |
| 8 | 50 56 | 9 4 | 71352 | 3 | 28648 | 78106 | 4 | 21894 | 06754 | 1 | 93246 | 52 |
| 9 | 50 48 | 9 12 | 71373 | 3 | 28627 | 78135 | 4 | 21865 | 06762 | 1 | 93238 | 51 |
| 10 | 7 50 40 | 4 9 20 | 9. 71393 | 3 | 10. 28607 | 9. 78163 | 5 | 10. 21837 | 10. 06770 | 1 | 9. 93230 | 50 |
| 11 | 50 32 | 9 28 | 71414 | 4 | 28586 | 78192 | 5 | 21808 | 06777 | 1 | 93223 | 49 |
| 12 | 50 24 | 9 36 | 71435 | 4 | 28565 | 78220 | 6 | 21780 | 06785 | 2 | 93215 | 48 |
| 13 | 50 16 | 9 44 | 71456 | 4 | 28544 | 78249 | 6 | 21751 | 06793 | 2 | 93207 | 47 |
| 14 | 50 8 | 9 52 | 71477 | 5 | 28523 | 78277 | 7 | 21723 | 06800 | 2 | 93200 | 46 |
| 15 | 7 50 0 | 4 10 0 | 9. 71498 | 5 | 10. 28502 | 9. 78306 | 7 | 10. 21694 | 10. 06808 | 2 | 9. 93192 | 45 |
| 16 | 49 52 | 10 8 | 71519 | 5 | 28481 | 78334 | 8 | 21666 | 06816 | 2 | 93184 | 44 |
| 17 | 49 44 | 10 16 | 71539 | 6 | 28461 | 78363 | 8 | 21637 | 06823 | 2 | 93177 | 43 |
| 18 | 49 36 | 10 24 | 71560 | 6 | 28440 | 78391 | 9 | 21609 | 06831 | 2 | 93169 | 42 |
| 19 | 49 28 | 10 32 | 71581 | 7 | 28419 | 78419 | 9 | 21581 | 06839 | 2 | 93161 | 41 |
| 20 | 7 49 20 | 4 10 40 | 9. 71602 | 7 | 10. 28398 | 9. 78448 | 9 | 10. 21552 | 10. 06846 | 3 | 9. 93154 | 40 |
| 21 | 49 12 | 10 48 | 71622 | 7 | 28378 | 78476 | 10 | 21524 | 06854 | 3 | 93146 | 39 |
| 22 | 49 4 | 10 56 | 71643 | 8 | 28357 | 78505 | 10 | 21495 | 06862 | 3 | 93138 | 38 |
| 23 | 48 56 | 11 4 | 71664 | 8 | 28336 | 78533 | 11 | 21467 | 06869 | 3 | 93131 | 37 |
| 24 | 48 48 | 11 12 | 71685 | 8 | 28315 | 78562 | 11 | 21438 | 06877 | 3 | 93123 | 36 |
| 25 | 7 48 40 | 4 11 20 | 9. 71705 | 9 | 10. 28295 | 9. 78590 | 12 | 10. 21410 | 10. 06885 | 3 | 9. 93115 | 35 |
| 26 | 48 32 | 11 28 | 71726 | 9 | 28274 | 78618 | 12 | 21382 | 06892 | 3 | 93108 | 34 |
| 27 | 48 24 | 11 36 | 71747 | 9 | 28253 | 78647 | 13 | 21353 | 06900 | 3 | 93100 | 33 |
| 28 | 48 16 | 11 44 | 71767 | 10 | 28233 | 78675 | 13 | 21325 | 06908 | 4 | 93092 | 32 |
| 29 | 48 8 | 11 52 | 71788 | 10 | 28212 | 78704 | 14 | 21296 | 06916 | 4 | 93084 | 31 |
| 30 | 7 48 0 | 4 12 0 | 9. 71809 | 10 | 10. 28191 | 9. 78732 | 14 | 10. 21268 | 10. 06923 | 4 | 9. 93077 | 30 |
| 31 | 47 52 | 12 8 | 71829 | 11 | 28171 | 78760 | 15 | 21240 | 06931 | 4 | 93069 | 29 |
| 32 | 47 44 | 12 16 | 71850 | 11 | 28150 | 78789 | 15 | 21211 | 06939 | 4 | 93061 | 28 |
| 33 | 47 36 | 12 24 | 71870 | 11 | 28130 | 78817 | 16 | 21183 | 06947 | 4 | 93053 | 27 |
| 34 | 47 28 | 12 32 | 71891 | 12 | 28109 | 78845 | 16 | 21155 | 06954 | 4 | 93046 | 26 |
| 35 | 7 47 20 | 4 12 40 | 9. 71911 | 12 | 10. 28089 | 9. 78874 | 17 | 10. 21126 | 10. 06962 | 5 | 9. 93038 | 25 |
| 36 | 47 12 | 12 48 | 71932 | 12 | 28068 | 78902 | 17 | 21098 | 06970 | 5 | 93030 | 24 |
| 37 | 47 4 | 12 56 | 71952 | 13 | 28048 | 78930 | 17 | 21070 | 06978 | 5 | 93022 | 23 |
| 38 | 46 56 | 13 4 | 71973 | 13 | 28027 | 78959 | 18 | 21041 | 06986 | 5 | 93014 | 22 |
| 39 | 46 48 | 13 12 | 71994 | 13 | 28006 | 78987 | 18 | 21013 | 06993 | 5 | 93007 | 21 |
| 40 | 7 46 40 | 4 13 20 | 9. 72014 | 14 | 10. 27986 | 9. 79015 | 19 | 10. 20985 | 10. 07001 | 5 | 9. 92999 | 20 |
| 41 | 46 32 | 13 28 | 72034 | 14 | 27966 | 79043 | 19 | 20957 | 07009 | 5 | 92991 | 19 |
| 42 | 46 24 | 13 36 | 72055 | 14 | 27945 | 79072 | 20 | 20928 | 07017 | 5 | 92983 | 18 |
| 43 | 46 16 | 13 44 | 72075 | 15 | 27925 | 79100 | 20 | 20900 | 07024 | 6 | 92976 | 17 |
| 44 | 46 8 | 13 52 | 72096 | 15 | 27904 | 79128 | 21 | 20872 | 07032 | 6 | 92968 | 16 |
| 45 | 7 46 0 | 4 14 0 | 9. 72116 | 15 | 10. 27884 | 9. 79156 | 21 | 10. 20844 | 10. 07040 | 6 | 9. 92960 | 15 |
| 46 | 45 52 | 14 8 | 72137 | 16 | 27863 | 79185 | 22 | 20815 | 07048 | 6 | 92952 | 14 |
| 47 | 45 44 | 14 16 | 72157 | 16 | 27843 | 79213 | 22 | 20787 | 07056 | 6 | 92944 | 13 |
| 48 | 45 36 | 14 24 | 72177 | 16 | 27823 | 79241 | 23 | 20759 | 07064 | 6 | 92936 | 12 |
| 49 | 45 28 | 14 32 | 72198 | 17 | 27802 | 79269 | 23 | 20731 | 07071 | 6 | 92929 | 11 |
| 50 | 7 45 20 | 4 14 40 | 9. 72218 | 17 | 10. 27782 | 9. 79297 | 24 | 10. 20703 | 10. 07079 | 6 | 9. 92921 | 10 |
| 51 | 45 12 | 14 48 | 72238 | 18 | 27762 | 79326 | 24 | 20674 | 07087 | 7 | 92913 | 9 |
| 52 | 45 4 | 14 56 | 72259 | 18 | 27741 | 79354 | 25 | 20646 | 07095 | 7 | 92905 | 8 |
| 53 | 44 56 | 15 4 | 72279 | 18 | 27721 | 79382 | 25 | 20618 | 07103 | 7 | 92897 | 7 |
| 54 | 44 48 | 15 12 | 72299 | 19 | 27701 | 79410 | 26 | 20590 | 07111 | 7 | 92889 | 6 |
| 55 | 7 44 40 | 4 15 20 | 9. 72320 | 19 | 10. 27680 | 9. 79438 | 26 | 10. 20562 | 10. 07119 | 7 | 9. 92881 | 5 |
| 56 | 44 32 | 15 28 | 72340 | 19 | 27660 | 79466 | 26 | 20534 | 07126 | 7 | 92874 | 4 |
| 57 | 44 24 | 15 36 | 72360 | 20 | 27640 | 79495 | 27 | 20505 | 07134 | 7 | 92866 | 3 |
| 58 | 44 16 | 15 44 | 72381 | 20 | 27619 | 79523 | 27 | 20477 | 07142 | 7 | 92858 | 2 |
| 59 | 44 8 | 15 52 | 72401 | 20 | 27599 | 79551 | 28 | 20449 | 07150 | 8 | 92850 | 1 |
| 60 | 44 0 | 16 0 | 72421 | 21 | 27579 | 79579 | 28 | 20421 | 07·158 | 8 | 92842 | 0 |

| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 121° | | | A | | A | B | | B | C | | C | 58° |

| Seconds of time ....... | | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ | |
|---|---|---|---|---|---|---|---|---|---|
| Prop. parts of cols. | A | 3 | 5 | 8 | 10 | 13 | 15 | 18 | |
| | B | 4 | 7 | 11 | 14 | 18 | 21 | 25 | |
| | C | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

32°　　　　A　　　　A　　　　B　　　　B　　　　C　　　　C　147°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 44 0 | 4 16 0 | 9.72421 | 0 | 10.27579 | 9.79579 | 0 | 10.20421 | 10.07158 | 0 | 9.92842 | 60 |
| 1 | 43 52 | 16 8 | 72441 | 0 | 27559 | 79607 | 0 | 20393 | 07166 | 0 | 92834 | 59 |
| 2 | 43 44 | 16 16 | 72461 | 1 | 27539 | 79635 | 1 | 20365 | 07174 | 0 | 92826 | 58 |
| 3 | 43 36 | 16 24 | 72482 | 1 | 27518 | 79663 | 1 | 20337 | 07182 | 0 | 92818 | 57 |
| 4 | 43 28 | 16 32 | 72502 | 1 | 27498 | 79691 | 2 | 20309 | 07190 | 1 | 92810 | 56 |
| 5 | 7 43 20 | 4 16 40 | 9.72522 | 2 | 10.27478 | 9.79719 | 2 | 10.20281 | 10.07197 | 1 | 9.92803 | 55 |
| 6 | 43 12 | 16 48 | 72542 | 2 | 27458 | 79747 | 3 | 20253 | 07205 | 1 | 92795 | 54 |
| 7 | 43 4 | 16 56 | 72562 | 2 | 27438 | 79776 | 3 | 20224 | 07213 | 1 | 92787 | 53 |
| 8 | 42 56 | 17 4 | 72582 | 3 | 27418 | 79804 | 4 | 20196 | 07221 | 1 | 92779 | 52 |
| 9 | 42 48 | 17 12 | 72602 | 3 | 27398 | 79832 | 4 | 20168 | 07229 | 1 | 92771 | 51 |
| 10 | 7 42 40 | 4 17 20 | 9.72622 | 3 | 10.27378 | 9.79860 | 5 | 10.20140 | 10.07237 | 1 | 9.92763 | 50 |
| 11 | 42 32 | 17 28 | 72643 | 4 | 27357 | 79888 | 5 | 20112 | 07245 | 1 | 92755 | 49 |
| 12 | 42 24 | 17 36 | 72663 | 4 | 27337 | 79916 | 6 | 20084 | 07253 | 2 | 92747 | 48 |
| 13 | 42 16 | 17 44 | 72683 | 4 | 27317 | 79944 | 6 | 20056 | 07261 | 2 | 92739 | 47 |
| 14 | 42 8 | 17 52 | 72703 | 5 | 27297 | 79972 | 7 | 20028 | 07269 | 2 | 92731 | 46 |
| 15 | 7 42 0 | 4 18 0 | 9.72723 | 5 | 10.27277 | 9.80000 | 7 | 10.20000 | 10.07277 | 2 | 9.92723 | 45 |
| 16 | 41 52 | 18 8 | 72743 | 5 | 27257 | 80028 | 7 | 19972 | 07285 | 2 | 92715 | 44 |
| 17 | 41 44 | 18 16 | 72763 | 6 | 27237 | 80056 | 8 | 19944 | 07293 | 2 | 92707 | 43 |
| 18 | 41 36 | 18 24 | 72783 | 6 | 27217 | 80084 | 8 | 19916 | 07301 | 2 | 92699 | 42 |
| 19 | 41 28 | 18 32 | 72803 | 6 | 27197 | 80112 | 9 | 19888 | 07309 | 3 | 92691 | 41 |
| 20 | 7 41 20 | 4 18 40 | 9.72823 | 7 | 10.27177 | 9.80140 | 9 | 10.19860 | 10.07317 | 3 | 9.92683 | 40 |
| 21 | 41 12 | 18 48 | 72843 | 7 | 27157 | 80168 | 10 | 19832 | 07325 | 3 | 92675 | 39 |
| 22 | 41 4 | 18 56 | 72863 | 7 | 27137 | 80195 | 10 | 19805 | 07333 | 3 | 92667 | 38 |
| 23 | 40 56 | 19 4 | 72883 | 8 | 27117 | 80223 | 11 | 19777 | 07341 | 3 | 92659 | 37 |
| 24 | 40 48 | 19 12 | 72902 | 8 | 27098 | 80251 | 11 | 19749 | 07349 | 3 | 92651 | 36 |
| 25 | 7 40 40 | 4 19 20 | 9.72922 | 8 | 10.27078 | 9.80279 | 12 | 10.19721 | 10.07357 | 3 | 9.92643 | 35 |
| 26 | 40 32 | 19 28 | 72942 | 9 | 27058 | 80307 | 12 | 19693 | 07365 | 3 | 92635 | 34 |
| 27 | 40 24 | 19 36 | 72962 | 9 | 27038 | 80335 | 13 | 19665 | 07373 | 4 | 92627 | 33 |
| 28 | 40 16 | 19 44 | 72982 | 9 | 27018 | 80363 | 13 | 19637 | 07381 | 4 | 92619 | 32 |
| 29 | 40 8 | 19 52 | 73002 | 10 | 26998 | 80391 | 13 | 19609 | 07389 | 4 | 92611 | 31 |
| 30 | 7 40 0 | 4 20 0 | 9.73022 | 10 | 10.26978 | 9.80419 | 14 | 10.19581 | 10.07397 | 4 | 9.92603 | 30 |
| 31 | 39 52 | 20 8 | 73041 | 10 | 26959 | 80447 | 14 | 19553 | 07405 | 4 | 92595 | 29 |
| 32 | 39 44 | 20 16 | 73061 | 11 | 26939 | 80474 | 15 | 19526 | 07413 | 4 | 92587 | 28 |
| 33 | 39 36 | 20 24 | 73081 | 11 | 26919 | 80502 | 15 | 19498 | 07421 | 4 | 92579 | 27 |
| 34 | 39 28 | 20 32 | 73101 | 11 | 26899 | 80530 | 16 | 19470 | 07429 | 5 | 92571 | 26 |
| 35 | 7 39 20 | 4 20 40 | 9.73121 | 12 | 10.26879 | 9.80558 | 16 | 10.19442 | 10.07437 | 5 | 9.92563 | 25 |
| 36 | 39 12 | 20 48 | 73140 | 12 | 26860 | 80586 | 17 | 19414 | 07445 | 5 | 92555 | 24 |
| 37 | 39 4 | 20 56 | 73160 | 12 | 26840 | 80614 | 17 | 19386 | 07454 | 5 | 92546 | 23 |
| 38 | 38 56 | 21 4 | 73180 | 13 | 26820 | 80642 | 18 | 19358 | 07462 | 5 | 92538 | 22 |
| 39 | 38 48 | 21 12 | 73200 | 13 | 26800 | 80669 | 18 | 19331 | 07470 | 5 | 92530 | 21 |
| 40 | 7 38 40 | 4 21 20 | 9.73219 | 13 | 10.26781 | 9.80697 | 19 | 10.19303 | 10.07478 | 5 | 9.92522 | 20 |
| 41 | 38 32 | 21 28 | 73239 | 14 | 26761 | 80725 | 19 | 19275 | 07486 | 6 | 92514 | 19 |
| 42 | 38 24 | 21 36 | 73259 | 14 | 26741 | 80753 | 20 | 19247 | 07494 | 6 | 92506 | 18 |
| 43 | 38 16 | 21 44 | 73278 | 14 | 26722 | 80781 | 20 | 19219 | 07502 | 6 | 92498 | 17 |
| 44 | 38 8 | 21 52 | 73298 | 15 | 26702 | 80808 | 20 | 19192 | 07510 | 6 | 92490 | 16 |
| 45 | 7 38 0 | 4 22 0 | 9.73318 | 15 | 10.26682 | 9.80836 | 21 | 10.19164 | 10.07518 | 6 | 9.92482 | 15 |
| 46 | 37 52 | 22 8 | 73337 | 15 | 26663 | 80864 | 21 | 19136 | 07527 | 6 | 92473 | 14 |
| 47 | 37 44 | 22 16 | 73357 | 16 | 26643 | 80892 | 22 | 19108 | 07535 | 6 | 92465 | 13 |
| 48 | 37 36 | 22 24 | 73377 | 16 | 26623 | 80919 | 22 | 19081 | 07543 | 6 | 92457 | 12 |
| 49 | 37 28 | 22 32 | 73396 | 16 | 26604 | 80947 | 23 | 19053 | 07551 | 7 | 92449 | 11 |
| 50 | 7 37 20 | 4 22 40 | 9.73416 | 17 | 10.26584 | 9.80975 | 23 | 10.19025 | 10.07559 | 7 | 9.92441 | 10 |
| 51 | 37 12 | 22 48 | 73435 | 17 | 26565 | 81003 | 24 | 18997 | 07567 | 7 | 92433 | 9 |
| 52 | 37 4 | 22 56 | 73455 | 17 | 26545 | 81030 | 24 | 18970 | 07575 | 7 | 92425 | 8 |
| 53 | 36 56 | 23 4 | 73474 | 18 | 26526 | 81058 | 25 | 18942 | 07584 | 7 | 92416 | 7 |
| 54 | 36 48 | 23 12 | 73494 | 18 | 26506 | 81086 | 25 | 18914 | 07592 | 7 | 92408 | 6 |
| 55 | 7 36 40 | 4 23 20 | 9.73513 | 18 | 10.26487 | 9.81113 | 26 | 10.18887 | 10.07600 | 7 | 9.92400 | 5 |
| 56 | 36 32 | 23 28 | 73533 | 19 | 26467 | 81141 | 26 | 18859 | 07608 | 8 | 92392 | 4 |
| 57 | 36 24 | 23 36 | 73552 | 19 | 26448 | 81169 | 26 | 18831 | 07616 | 8 | 92384 | 3 |
| 58 | 36 16 | 23 44 | 73572 | 19 | 26428 | 81196 | 27 | 18804 | 07624 | 8 | 92376 | 2 |
| 59 | 36 8 | 23 52 | 73591 | 20 | 26409 | 81224 | 27 | 18776 | 07633 | 8 | 92367 | 1 |
| 60 | 36 0 | 24 0 | 73611 | 20 | 26389 | 81252 | 28 | 18748 | 07641 | 8 | 92359 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |

122°　　　　A　　　　A　　　　B　　　　B　　　　C　　　　C　57°

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 2 | 5 | 7 | 10 | 12 | 15 | 17 |
| B | 3 | 7 | 10 | 14 | 17 | 21 | 24 |
| C | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

TABLE 44. [Page 641

Log. Sines, Tangents, and Secants.

33°　　　　　　　　　　A　　　　　A　　　B　　　　B　　　C　　　　　C　　146°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 36 0 | 4 24 0 | 9. 73611 | 0 | 10. 26389 | 9. 81252 | 0 | 10. 18748 | 10. 07641 | 0 | 9. 92359 | 60 |
| 1 | 35 52 | 24 8 | 73630 | 0 | 26370 | 81279 | 0 | 18721 | 07649 | 0 | 92351 | 59 |
| 2 | 35 44 | 24 16 | 73650 | 1 | 26350 | 81307 | 1 | 18693 | 07657 | 0 | 92343 | 58 |
| 3 | 35 36 | 24 24 | 73669 | 1 | 26331 | 81335 | 1 | 18665 | 07665 | 0 | 92335 | 57 |
| 4 | 35 28 | 24 32 | 73689 | 1 | 26311 | 81362 | 2 | 18638 | 07674 | 1 | 92326 | 56 |
| 5 | 7 35 20 | 4 24 40 | 9. 73708 | 2 | 10. 26292 | 9. 81390 | 2 | 10. 18610 | 10. 07682 | 1 | 9. 92318 | 55 |
| 6 | 35 12 | 24 48 | 73727 | 2 | 26273 | 81418 | 3 | 18582 | 07690 | 1 | 92310 | 54 |
| 7 | 35 4 | 24 56 | 73747 | 2 | 26253 | 81445 | 3 | 18555 | 07698 | 1 | 92302 | 53 |
| 8 | 34 56 | 25 4 | 73766 | 3 | 26234 | 81473 | 4 | 18527 | 07707 | 1 | 92293 | 52 |
| 9 | 34 48 | 25 12 | 73785 | 3 | 26215 | 81500 | 4 | 18500 | 07715 | 1 | 92285 | 51 |
| 10 | 7 34 40 | 4 25 20 | 9. 73805 | 3 | 10. 26195 | 9. 81528 | 5 | 10. 18472 | 10. 07723 | 1 | 9. 92277 | 50 |
| 11 | 34 32 | 25 28 | 73824 | 3 | 26176 | 81556 | 5 | 18444 | 07731 | 2 | 92269 | 49 |
| 12 | 34 24 | 25 36 | 73843 | 4 | 26157 | 81583 | 5 | 18417 | 07740 | 2 | 92260 | 48 |
| 13 | 34 16 | 25 44 | 73863 | 4 | 26137 | 81611 | 6 | 18389 | 07748 | 2 | 92252 | 47 |
| 14 | 34 8 | 25 52 | 73882 | 4 | 26118 | 81638 | 6 | 18362 | 07756 | 2 | 92244 | 46 |
| 15 | 7 34 0 | 4 26 0 | 9. 73901 | 5 | 10. 26099 | 9. 81666 | 7 | 10. 18334 | 10. 07765 | 2 | 9. 92235 | 45 |
| 16 | 33 52 | 26 8 | 73921 | 5 | 26079 | 81693 | 7 | 18307 | 07773 | 2 | 92227 | 44 |
| 17 | 33 44 | 26 16 | 73940 | 5 | 26060 | 81721 | 8 | 18279 | 07781 | 2 | 92219 | 43 |
| 18 | 33 36 | 26 24 | 73959 | 6 | 26041 | 81748 | 8 | 18252 | 07789 | 3 | 92211 | 42 |
| 19 | 33 28 | 26 32 | 73978 | 6 | 26022 | 81776 | 9 | 18224 | 07798 | 3 | 92202 | 41 |
| 20 | 7 33 20 | 4 26 40 | 9. 73997 | 6 | 10. 26003 | 9. 81803 | 9 | 10. 18197 | 10. 07806 | 3 | 9. 92194 | 40 |
| 21 | 33 12 | 26 48 | 74017 | 7 | 25983 | 81831 | 10 | 18169 | 07814 | 3 | 92186 | 39 |
| 22 | 33 4 | 26 56 | 74036 | 7 | 25964 | 81858 | 10 | 18142 | 07823 | 3 | 92177 | 38 |
| 23 | 32 56 | 27 4 | 74055 | 7 | 25945 | 81886 | 11 | 18114 | · 07831 | 3 | 92169 | 37 |
| 24 | 32 48 | 27 12 | 74074 | 8 | 25926 | 81913 | 11 | 18087 | 07839 | 3 | 92161 | 36 |
| 25 | 7 32 40 | 4 27 20 | 9. 74093 | 8 | 10. 25907 | 9. 81941 | 11 | 10. 18059 | 10. 07848 | 3 | 9. 92152 | 35 |
| 26 | 32 32 | 27 28 | 74113 | 8 | 25887 | 81968 | 12 | 18032 | 07856 | 4 | 92144 | 34 |
| 27 | 32 24 | 27 36 | 74132 | 9 | 25868 | 81996 | 12 | 18004 | 07864 | 4 | 92136 | 33 |
| 28 | 32 16 | 27 44 | 74151 | 9 | 25849 | 82023 | 13 | 17977 | 07873 | 4 | 92127 | 32 |
| 29 | 32 8 | 27 52 | 74170 | 9 | 25830 | 82051 | 13 | 17949 | 07881 | 4 | 92119 | 31 |
| 30 | 7 32 0 | 4 28 0 | 9. 74189 | 10 | 10. 25811 | 9. 82078 | 14 | 10. 17922 | 10. 07889 | 4 | 9. 92111 | 30 |
| 31 | 31 52 | 28 8 | 74208 | 10 | 25792 | 82106 | 14 | 17894 | 07898 | 4 | 92102 | 29 |
| 32 | 31 44 | 28 16 | 74227 | 10 | 25773 | 82133 | 15 | 17867 | 07906 | 4 | 92094 | 28 |
| 33 | 31 36 | 28 24 | 74246 | 10 | 25754 | 82161 | 15 | 17839 | 07914 | 5 | 92086 | 27 |
| 34 | 31 28 | 28 32 | 74265 | 11 | 25735 | 82188 | 16 | 17812 | 07923 | 5 | 92077 | 26 |
| 35 | 7 31 20 | 4 28 40 | 9. 74284 | 11 | 10. 25716 | 9. 82215 | 16 | 10. 17785 | 10. 07931 | 5 | 9. 92069 | 25 |
| 36 | 31 12 | 28 48 | 74303 | 11 | 25697 | 82243 | 16 | 17757 | 07940 | 5 | 92060 | 24 |
| 37 | 31 4 | 28 56 | 74322 | 12 | 25678 | 82270 | 17 | 17730 | 07948 | 5 | 92052 | 23 |
| 38 | 30 56 | 29 4 | 74341 | 12 | 25659 | 82298 | 17 | 17702 | 07956 | 5 | 92044 | 22 |
| 39 | 30 48 | 29 12 | 74360 | 12 | 25640 | 82325 | 18 | 17675 | 07965 | 5 | 92035 | 21 |
| 40 | 7 30 40 | 4 29 20 | 9. 74379 | 13 | 10. 25621 | 9. 82352 | 18 | 10. 17648 | 10. 07973 | 6 | 9. 92027 | 20 |
| 41 | 30 32 | 29 28 | 74398 | 13 | 25602 | 82380 | 19 | 17620 | 07982 | 6 | 92018 | 19 |
| 42 | 30 24 | 29 36 | 74417 | 13 | 25583 | 82407 | 19 | 17593 | 07990 | 6 | 92010 | 18 |
| 43 | 30 16 | 29 44 | 74436 | 14 | 25564 | 82435 | 20 | 17565 | 07998 | 6 | 92002 | 17 |
| 44 | 30 8 | 29 52 | 74455 | 14 | 25545 | 82462 | 20 | 17538 | ˏ08007 | 6 | 91993 | 16 |
| 45 | 7 30 0 | 4 30 0 | 9. 74474 | 14 | 10. 25526 | 9. 82489 | 21 | 10. 17511 | 10. 08015 | 6 | 9. 91985 | 15 |
| 46 | 29 52 | 30 8 | 74493 | 15 | 25507 | 82517 | 21 | 17483 | 08024 | 6 | 91976 | 14 |
| 47 | 29 44 | 30 16 | 74512 | 15 | 25488 | 82544 | 22 | 17456 | 08032 | 7 | 91968 | 13 |
| 48 | 29 36 | 30 24 | 74531 | 15 | 25469 | 82571 | 22 | 17429 | 08041 | 7 | 91959 | 12 |
| 49 | 29 28 | 30 32 | 74549 | 16 | 25451 | 82599 | 22 | 17401 | 08049 | 7 | 91951 | 11 |
| 50 | 7 29 20 | 4 30 40 | 9. 74568 | 16 | 10. 25432 | 9. 82626 | 23 | 10. 17374 | 10. 08058 | 7 | 9. 91942 | 10 |
| 51 | 29 12 | 30 48 | 74587 | 16 | 25413 | 82653 | 23 | 17347 | 08066 | 7 | 91934 | 9 |
| 52 | 29 4 | 30 56 | 74606 | 17 | 25394 | 82681 | 24 | 17319 | 08075 | 7 | 91925 | 8 |
| 53 | 28 56 | 31 4 | 74625 | 17 | 25375 | 82708 | 24 | 17292 | 08083 | 7 | 91917 | 7 |
| 54 | 28 48 | 31 12 | 74644 | 17 | 25356 | 82735 | 25 | 17265 | 08092 | 8 | 91908 | 6 |
| 55 | 7 28 40 | 4 31 20 | 9. 74662 | 17 | 10. 25338 | 9. 82762 | 25 | 10. 17374 | 10. 08100 | 8 | 9. 91900 | 5 |
| 56 | 28 32 | 31 28 | 74681 | 18 | 25319 | 82790 | 26 | 17210 | 08109 | 8 | 91891 | 4 |
| 57 | 28 24 | 31 36 | 74700 | 18 | 25300 | 82817 | 26 | 17183 | 08117 | 8 | 91883 | 3 |
| 58 | 28 16 | 31 44 | 74719 | 18 | 25281 | 82844 | 27 | 17156 | 08126 | 8 | 91874 | 2 |
| 59 | 28 8 | 31 52 | 74737 | 19 | 25263 | 82871 | 27 | 17129 | 08134 | 8 | 91866 | 1 |
| 60 | 28 0 | 32 0 | 74756 | 19 | 25244 | 82899 | 27 | 17101 | 08143 | 8 | 91857 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

123°　　　　　　　　A　　　　　　′.　　　　B　　　　　B　　　C　　　　　C　　56°

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 2 | 5 | 7 | 10 | 12 | 14 | 17 |
| {B | 3 | 7 | 10 | 14 | 17 | 21 | 24 |
| {C | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

34°        A       A       B       B       C       C     145°

| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 28 0 | 4 32 0 | 9.74756 | 0 | 10.25244 | 9.82899 | 0 | 10.17101 | 10.08143 | 0 | 9.91857 | 60 |
| 1 | 27 52 | 32 8 | 74775 | 0 | 25225 | 82926 | 0 | 17074 | 08151 | 0 | 91849 | 59 |
| 2 | 27 44 | 32 16 | 74794 | 1 | 25206 | 82953 | 1 | 17047 | 08160 | 0 | 91840 | 58 |
| 3 | 27 36 | 32 24 | 74812 | 1 | 25188 | 82980 | 1 | 17020 | 08168 | 0 | 91832 | 57 |
| 4 | 27 28 | 32 32 | 74831 | 1 | 25169 | 83008 | 2 | 16992 | 08177 | 1 | 91823 | 56 |
| 5 | 7 27 20 | 4 32 40 | 9.74850 | 2 | 10.25150 | 9.83035 | 2 | 10.16965 | 10.08185 | 1 | 9.91815 | 55 |
| 6 | 27 12 | 32 48 | 74868 | 2 | 25132 | 83062 | 3 | 16938 | 08194 | 1 | 91806 | 54 |
| 7 | 27 4 | 32 56 | 74887 | 2 | 25113 | 83089 | 3 | 16911 | 08202 | 1 | 91798. | 53 |
| 8 | 26 56 | 33 4 | 74906 | 2 | 25094 | 83117 | 4 | 16883 | 08211 | 1 | 91789 | 52 |
| 9 | 26 48 | 33 12 | 74924 | 3 | 25076 | 83144 | 4 | 16856 | 08219 | 1 | 91781 | 51 |
| 10 | 7 26 40 | 4 33 20 | 9.74943 | 3 | 10.25057 | 9.83171 | 5 | 10.16829 | 10.08228 | 1 | 9.91772 | 50 |
| 11 | 26 32 | 33 28 | 74961 | 3 | 25039 | 83198 | 5 | 16802 | 08237 | 2 | 91763 | 49 |
| 12 | 26 24 | 33 36 | 74980 | 4 | 25020 | 83225 | 5 | 16775 | 08245 | 2 | 91755 | 48 |
| 13 | 26 16 | 33 44 | 74999 | 4 | 25001 | 83252 | 6 | 16748 | 08254 | 2 | 91746 | 47 |
| 14 | 26 8 | 33 52 | 75017 | 4 | 24983 | 83280 | 6 | 16720 | 08262 | 2 | 91738 | 46 |
| 15 | 7 26 0 | 4 34 0 | 9.75036 | 5 | 10.24964 | 9.83307 | 7 | 10.16693 | 10.08271 | 2 | 9.91729 | 45 |
| 16 | 25 52 | 34 8 | 75054 | 5 | 24946 | 83334 | 7 | 16666 | 08280 | 2 | 91720 | 44 |
| 17 | 25 44 | 34 16 | 75073 | 5 | 24927 | 83361 | .8 | 16639 | 08288 | 2 | 91712 | 43 |
| 18 | 25 36 | 34 24 | 75091 | 6 | 24909 | 83388 | 8 | 16612 | 08297 | 3 | 91703 | 42 |
| 19 | 25 28 | 34 32 | 75110 | 6 | 24890 | 83415 | 9 | 16585 | 08305 | 3 | 91695 | 41 |
| 20 | 7 25 20 | 4 34 40 | 9.75128 | 6 | 10.24872 | 9.83442 | 9 | 10.16558 | 10.08314 | 3 | 9.91686 | 40 |
| 21 | 25 12 | 34 48 | 75147 | 6 | 24853 | 83470 | 9 | 16530 | 08323 | 3 | 91677 | 39 |
| 22 | 25 4 | 34 56 | 75165 | 7 | 24835 | 83497 | 10 | 16503 | 08331 | 3 | 91669 | 38 |
| 23 | 24 56 | 35 4 | 75184 | 7 | 24816 | 83524 | 10 | 16476 | 08340 | 3 | 91660 | 37 |
| 24 | 24 48 | 35 12 | 75202 | 7 | 24798 | 83551 | 11 | 16449 | 08349 | 3 | 91651 | 36 |
| 25 | 7 24 40 | 4 35 20 | 9.75221 | 8 | 10.24779 | 9.83578 | 11 | 10.16422 | 10.08357 | 4 | 9.91643 | 35 |
| 26 | 24 32 | 35 28 | 75239 | 8 | 24761 | 83605 | 12 | 16395 | 08366 | 4 | 91634 | 34 |
| 27 | 24 24 | 35 36 | 75258 | 8 | 24742 | 83632 | 12 | 16368 | 08375 | 4 | 91625 | 33 |
| 28 | 24 16 | 35 44 | 75276 | 9 | 24724 | 83659 | 13 | 16341 | 08383 | 4 | 91617 | 32 |
| 29 | 24 8 | 35 52 | 75294 | 9 | 24706 | 83686 | 13 | 16314 | 08392 | 4 | 91608 | 31 |
| 30 | 7 24 0 | 4 36 0 | 9.75313 | 9 | 10.24687 | 9.83713 | 14 | 10.16287 | 10.08401 | 4 | 9.91599 | 30 |
| 31 | 23 52 | 36 8 | 75331 | 9 | 24669 | 83740 | 14 | 16260 | 08409 | 4 | 91591 | 29 |
| 32 | 23 44 | 36 16 | 75350 | 10 | 24650 | 83768 | 14 | 16232 | 08418 | 5 | 91582 | 28 |
| 33 | 23 36 | 36 24 | 75368 | 10 | 24632 | 83795 | 15 | 16205 | 08427 | 5 | 91573 | 27 |
| 34 | 23 28 | 36 32 | 75386 | 10 | 24614 | 83822 | 15 | 16178 | 08435 | 5 | 91565 | 26 |
| 35 | 7 23 20 | 4 36 40 | 9.75405 | 11 | 10.24595 | 9.83849 | 16 | 10.16151 | 10.08444 | 5 | 9.91556 | 25 |
| 36 | 23 12 | 36 48 | 75423 | 11 | 24577 | 83876 | 16 | 16124 | 08453 | 5 | 91547 | 24 |
| 37 | 23 4 | 36 56 | 75441 | 11 | 24559 | 83903 | 17 | 16097 | 08462 | 5 | 91538 | 23 |
| 38 | 22 56 | 37 4 | 75459 | 12 | 24541 | 83920 | 17 | 16070 | 08470 | 5 | 91530 | 22 |
| 39 | 22 48 | 37 12 | 75478 | 12 | 24522 | 83957 | 18 | 16043 | 08479 | 6 | 91521 | 21 |
| 40 | 7 22 40 | 4 37 20 | 9.75496 | 12 | 10.24504 | 9.83984 | 18 | 10.16016 | 10.08488 | 6 | 9.91512 | 20 |
| 41 | 22 32 | 37 28 | 75514 | 13 | 24486 | 84011 | 18 | 15989 | 08496 | 6 | 91504 | 19 |
| 42 | 22 24 | 37 36 | 75533 | 13 | 24467 | 84038 | 19 | 15962 | 08505 | 6 | 91495 | 18 |
| 43 | 22 16 | 37 44 | 75551 | 13 | 24449 | 84065 | 19 | 15935 | · 08514 | 6 | 91486 | 17 |
| 44 | 22 8 | 37 52 | , 75569 | 13 | 24431 | 84092 | 20 | 15908 | 08523 | 6 | 91477 | 16 |
| 45 | 7 22 0 | 4 38 0 | 9.75587 | 14 | 10.24413 | 9.84119 | 20 | 10.15881 | 10.08531 | 7 | 9.91469 | 15 |
| 46 | 21 52 | 38 8 | 75605 | 14 | 24395 | 84146 | 21 | 15854 | 08540 | 7 | 91460 | 14 |
| 47 | 21 44 | 38 16 | 75624 | 14 | 24376 | 84173 | 21 | 15827 | 08549 | 7 | 91451 | 13 |
| 48 | 21 36 | 38 24 | 75642 | 15 | 24358 | 84200 | 22 | 15800 | 08558 | 7 | 91442 | 12 |
| 49 | 21 28 | 38 32 | 75660 | 15 | 24340 | 84227 | 22 | 15773 | 08567 | 7 | 91433 | 11 |
| 50 | 7 21 20 | 4 38 40 | 9.75678 | 15 | 10.24322 | 9.84254 | 23 | 10.15746 | 10.08575 | 7 | 9.91425 | 10 |
| 51 | 21 12 | 38 48 | 75696 | 16 | 24304 | 84280 | 23 | 15720 | 08584 | 7 | 91416 | 9 |
| 52 | 21 4 | 38 56 | 75714 | 16 | 24286 | 84307 | 23 | 15693 | 08593 | 8 | 91407 | 8 |
| 53 | 20 56 | 39 4 | 75733 | 16 | 24267 | 84334 | 24 | 15666 | 08602 | 8 | 91398 | 7 |
| 54 | 20 48 | 39 12 | 75751 | 17 | 24249 | 84361 | 24 | 15639 | 08611 | 8 | 91389 | 6 |
| 55 | 7 20 40 | 4 39 20 | 9.75769 | 17 | 10.24231 | 9.84388 | 25 | 10.15612 | 10.08619 | 8 | 9.91381 | 5 |
| 56 | 20 32 | 39 28 | 75787 | 17 | 24213 | 84415 | 25 | 15585 | 08628 | 8 | 91372 | 4 |
| 57 | 20 24 | 39 36 | 75805 | 17 | 24195 | 84442 | 26 | 15558 | 08637 | 8 | 91363 | 3 |
| 58 | 20 16 | 39 44 | 75823 | 18 | 24177 | 84469 | 26 | 15531 | 08646 | 8 | 91354 | 2 |
| 59 | 20 8 | 39 52 | 75841 | 18 | 24159 | 84496 | 27 | 15504 | 08655 | 9 | 91345 | 1 |
| 60 | 20 0 | 40 0 | 75859 | 18 | 24141 | 84523 | 27 | 15477 | 08664 | 9 | 91336 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |

124°        A       A       B       B       C       C     55

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. A | 2 | 5 | 7 | 9 | 11 | 14 | 16 |
| B | 3 | 7 | 10 | 14 | 17 | 20 | 24 |
| C | 1 | 2 | 2 | 3 | 4 | 5 | 7 | 8 |

# TABLE 44. [Page 643

Log. Sines, Tangents, and Secants.

35°     A     A     B     B     C     C     144°

| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 20 0 | 4 40 0 | 9.75859 | 0 | 10.24141 | 9.84523 | 0 | 10.15477 | 10.08664 | 0 | 9.91336 | 60 |
| 1 | 19 52 | 40 8 | 75877 | 0 | 24123 | 84550 | 0 | 15450 | 08672 | 0 | 91328 | 59 |
| 2 | 19 44 | .40 16 | 75895 | 1 | 24105 | 84576 | 1 | 15424 | 08681 | 0 | 91319 | 58 |
| 3 | 19 36 | 40 24 | 75913 | 1 | 24087 | 84603 | 1 | 15397 | 08690 | 0 | 91310 | 57 |
| 4 | 19 28 | 40 32 | 75931 | 1 | 24069 | 84630 | 2 | 15370 | 08699 | 1 | 91301 | 56 |
| 5 | 7 19 20 | 4 40 40 | 9.75949 | 1 | 10.24051 | 9.84657 | 2 | 10.15343 | 10.08708 | 1 | 9.91292 | 55 |
| 6 | 19 12 | 40 48 | 75967 | 2 | 24033 | 84684 | 3 | 15316 | 08717 | 1 | 91283 | 54 |
| 7 | 19 4 | 40 56 | 75985 | 2 | 24015 | 84711 | 3 | 15289 | 08726 | 1 | 91274 | 53 |
| 8 | 18 56 | 41 4 | 76003 | 2 | 23997 | 84738 | 4 | 15262 | 08734 | 1 | 91266 | 52 |
| 9 | 18 48 | 41 12 | 76021 | 3 | 23979 | 84764 | 4 | 15236 | 08743 | 1 | 91257 | 51 |
| 10 | 7 18 40 | 4 41 20 | 9.76039 | 3 | 10.23961 | 9.84791 | 4 | 10.15209 | 10.08752 | 2 | 9.91248 | 50 |
| 11 | 18 32 | 41 28 | 76057 | 3 | 23943 | 84818 | 5 | 15182 | 08761 | 2 | 91239 | 49 |
| 12 | 18 24 | 41 36 | 76075 | 4 | 23925 | 84845 | 5 | 15155 | 08770 | 2 | 91230 | 48 |
| 13 | 18 16 | 41 44 | 76093 | 4 | 23907 | 84872 | 6 | 15128 | 08779 | 2 | 91221 | 47 |
| 14 | 18 8 | 41 52 | 76111 | 4 | 23889 | 84899 | 6 | 15101 | 08788 | 2 | 91212 | 46 |
| 15 | 7 18 0 | 4 42 0 | 9.76129 | 4 | 10.23871 | 9.84925 | 7 | 10.15075 | 10.08797 | 2 | 9.91203 | 45 |
| 16 | 17 52 | 42 8 | 76146 | 5 | 23854 | 84952 | 7 | 15048 | 08806 | 2 | 91194 | 44 |
| 17 | 17 44 | 42 16 | 76164 | 5 | 23836 | 84979 | 8 | 15021 | 08815 | 3 | 91185 | 43 |
| 18 | 17 36 | 42 24 | 76182 | 5 | 23818 | 85006 | 8 | 14994 | 08824 | 3 | 91176 | 42 |
| 19 | 17 28 | 42 32 | 76200 | 6 | 23800 | 85033 | 8 | 14967 | 08833 | 3 | 91167 | 41 |
| 20 | 7 17 20 | 4 42 40 | 9.76218 | 6 | 10.23782 | 9.85059 | 9 | 10.14941 | 10.08842 | 3 | 9.91158 | 40 |
| 21 | 17 12 | 42 48 | 76236 | 6 | 23764 | 85086 | 9 | 14914 | 08851 | 3 | 91149 | 39 |
| 22 | 17 4 | 42 56 | 76253 | 6 | 23747 | 85113 | 10 | 14887 | 08859 | 3 | 91141 | 38 |
| 23 | 16 56 | 43 4 | 76271 | 7 | 23729 | 85140 | 10 | 14860 | 08868 | 3 | 91132 | 37 |
| 24 | 16 48 | 43 12 | 76289 | 7 | 23711 | 85166 | 11 | 14834 | 08877 | 4 | 91123 | 36 |
| 25 | 7 16 40 | 4 43 20 | 9.76307 | 7 | 10.23693 | 9.85193 | 11 | 10.14807 | 10.08886 | 4 | 9.91114 | 35 |
| 26 | 16 32 | 43 28 | 76324 | 8 | 23676 | 85220 | 12 | 14780 | .08895 | 4 | .91105 | 34 |
| 27 | 16 24 | . 43 36 | 76342 | 8 | 23658 | 85247 | 12 | 14753 | 08904 | 4 | 91096 | 33 |
| 28 | 16 16 | 43 44 | 76360 | 8 | 23640 | · 85273 | 12 | 14727 | 08913 | 4 | 91087 | 32 |
| 29 | 16 8 | 43 52 | 76378 | 9 | 23622 | 85300 | 13 | 14700 | 08922 | 4 | 91078 | 31 |
| 30 | 7 16 0 | 4 44 0 | 9.76395 | 9 | 10.23605 | 9.85327 | 13 | 10.14673 | 10.08931 | 5 | 9.91069 | 30 |
| 31 | 15 52 | 44 8 | 76413 | 9 | 23587 | 85354 | 14 | 14646 | 08940 | 5 | 91060 | 29 |
| 32 | 15 44 | 44 16 | 76431 | 9 | 23569 | 85380 | 14 | 14620 | 08949 | 5 | 91051 | 28 |
| 33 | 15 36 | 44 24 | 76448 | 10 | 23552 | 85407 | 15 | 14593 | 08958 | 5 | 91042 | 27 |
| 34 | 15 28 | 44 32 | 76466 | 10 | 23534 | 85434 | 15 | 14566 | 08967 | 5 | 91033 | 26 |
| 35 | 7 15 20 | 4 44 40 | 9.76484 | 10 | 10.23516 | 9.85460 | 16 | 10.14540 | 10.08977 | 5 | 9.91023 | 25 |
| 36 | 15 12 | 44 48 | 76501 | 11 | 23499 | 85487 | 16 | 14513 | 08986 | 5 | 91014 | 24 |
| 37 | 15 4 | 44 56 | 76519 | 11 | 23481 | 85514 | 16 | 14486 | 08995 | 6 | 91005 | 23 |
| 38 | 14 56 | 45 4 | 76537 | 11 | 23463 | 85540 | 17 | 14460 | 09004 | 6 | 90996 | 22 |
| 39 | 14 48 | 45 12 | 76554 | 12 | 23446 | 85567 | 17 | 14433 | 09013 | 6 | 90987 | 21 |
| 40 | 7 14 40 | 4 45 20 | 9.76572 | 12 | 10.23428 | 9.85594 | 18 | 10.14406 | 10.09022 | 6 | 9.90978 | 20 |
| 41 | 14 32 | 45 28 | 76590 | 12 | 23410 | 85620 | 18 | 14380 | 09031 | 6 | 90969 | 19 |
| 42 | 14 24 | 45 36 | 76607 | 12 | 23393 | 85647 | 19 | 14353 | 09040 | 6 | 90960 | 18 |
| 43 | 14 16 | 45 44 | 76625 | 13 | 23375 | 85674 | 19 | 14326 | 09049 | 6 | 90951 | 17 |
| 44 | 14 8 | 45 52 | 76642 | 13 | 23358 | 85700 | 20 | 14300 | 09058 | 7 | 90942 | 16 |
| 45 | 7 14 0 | 4 46 0 | 9.76660 | 13 | 10.23340 | 9.85727 | 20 | 10.14273 | 10.09067 | 7 | 9.90933 | 15 |
| 46 | 13 52 | 46 8 | 76677 | 14 | 23323 | 85754 | 20 | 14246 | 09076 | 7 | 90924 | 14 |
| 47 | 13 44 | 46 16 | 76695 | 14 | 23305 | 85780 | 21 | 14220 | 09085 | 7 | 90915 | 13 |
| 48 | 13 36 | 46 24 | 76712 | 14 | 23288 | 85807 | 21 | 14193 | 09094 | 7 | 90906 | 12 |
| 49 | 13 28 | 46 32 | 76730 | 14 | 23270 | 85834 | 22 | 14166 | 09104 | 7 | 90896 | 11 |
| 50 | 7 13 20 | 4 46 40 | 9.76747 | 15 | 10.23253 | 9.85860 | 22 | 10.14140 | 10.09113 | 8 | 9.90887 | 10 |
| 51 | 13 12 | 46 48 | 76765 | 15 | 23235 | 85887 | 23 | 14113 | 09122 | 8 | 90878 | 9 |
| 52 | 13 4 | 46 56 | 76782 | 15 | 23218 | 85913 | 23 | 14087 | 09131 | 8 | 90869 | 8 |
| 53 | 12 56 | 47 4 | 76800 | 16 | 23200 | 85940 | 24 | 14060 | 09140 | 8 | 90860 | 7 |
| 54 | 12 48 | 47 12 | 76817 | 16 | 23183 | 85967 | 24 | 14033 | 09149 | 8 | 90851 | 6 |
| 55 | 7 12 40 | 4 47 20 | 9.76835 | 16 | 10.23165 | 9.85993 | 24 | 10.14007 | 10.09158 | 8 | 9.90842 | 5 |
| 56 | 12 32 | 47 28 | 76852 | 17 | 23148 | 86020 | 25 | 13980 | 09168 | 8 | 90832 | 4 |
| 57 | 12 24 | 47 36 | 76870 | 17 | 23130 | 86046 | 25 | 13954 | 09177 | 9 | 90823 | 3 |
| 58 | 12 16 | 47 44 | 76887 | 17 | 23113 | 86073 | 26 | 13927 | 09186 | 9 | 90814 | 2 |
| 59 | 12 8 | 47 52 | 76904 | 17 | 23096 | 86100 | 26 | 13900 | 09195 | 9 | 90805 | 1 |
| 60 | 12 0 | 48 0 | 76922 | 18 | 23078 | 86126 | 27 | 13874 | 09204 | 9 | 90796 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |

125°     A     A     B     B     C     C     54°

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 2 | 4 | 7 | 9 | 11 | 13 | 16 |
| B | 3 | 7 | 10 | 13 | 17 | 20 | 23 |
| C | 1 | 2 | 3 | 5 | 6 | 7 | 8 |

# TABLE 44.

### Log. Sines, Tangents, and Secants.

| 36° | | | A | | A | B | | B | C | | C | 143° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 7 12 0 | 4 48 0 | 9.76922 | 0 | 10.23078 | 9.86126 | 0 | 10.13874 | 10.09204 | 0 | 9.90796 | 60 |
| 1 | 11 52 | 48 8 | 76939 | 0 | 23061 | 86153 | 0 | 13847 | 09213 | 0 | 90787 | 59 |
| 2 | 11 44 | 48 16 | 76957 | 1 | 23043 | 86179 | 1 | 13821 | 09223 | 0 | 90777 | 58 |
| 3 | 11 36 | 48 24 | 76974 | 1 | 23026 | 86206 | 1 | 13794 | 09232 | 0 | 90768 | 57 |
| 4 | 11 28 | 48 32 | 76991 | 1 | 23009 | 86232 | 2 | 13768 | 09241 | 1 | 90759 | 56 |
| 5 | 7 11 20 | 4 48 40 | 9.77009 | 1 | 10.22991 | 9.86259 | 2 | 10.13741 | 10.09250 | 1 | 9.90750 | 55 |
| 6 | 11 12 | 48 48 | 77026 | 2 | 22974 | 86285 | 3 | 13715 | 09259 | 1 | 90741 | 54 |
| 7 | 11 4 | 48 56 | 77043 | 2 | 22957 | 86312 | 3 | 13688 | 09269 | 1 | 90731 | 53 |
| 8 | 10 56 | 49 4 | 77061 | 2 | 22939 | 86338 | 4 | 13662 | 09278 | 1 | 90722 | 52 |
| 9 | 10 48 | 49 12 | 77078 | 3 | 22922 | 86365 | 4 | 13635 | 09287 | 1 | 90713 | 51 |
| 10 | 7 10 40 | 4 49 20 | 9.77095 | 3 | 10.22905 | 9.86392 | 4 | 10.13608 | 10.09296 | 2 | 9.90704 | 50 |
| 11 | 10 32 | 49 28 | 77112 | 3 | 22888 | 86418 | 5 | 13582 | 09306 | 2 | 90694 | 49 |
| 12 | 10 24 | 49 36 | 77130 | 3 | 22870 | 86445 | 5 | 13555 | 09315 | 2 | 90685 | 48 |
| 13 | 10 16 | 49 44 | 77147 | 4 | 22853 | 86471 | 6 | 13529 | 09324 | 2 | 90676 | 47 |
| 14 | 10 8 | 49 52 | 77164 | 4 | 22836 | 86498 | 6 | 13502 | 09333 | 2 | 90667 | 46 |
| 15 | 7 10 0 | 4 50 0 | 9.77181 | 4 | 10.22819 | 9.86524 | 7 | 10.13476 | 10.09343 | 2 | 9.90657 | 45 |
| 16 | 9 52 | 50 8 | 77199 | 5 | 22801 | 86551 | 7 | 13449 | 09352 | 2 | 90648 | 44 |
| 17 | 9 44 | 50 16 | 77216 | 5 | 22784 | 86577 | 7 | 13423 | 09361 | 3 | 90639 | 43 |
| 18 | 9 36 | 50 24 | 77233 | 5 | 22767 | 86603 | 8 | 13397 | 09370 | 3 | 90630 | 42 |
| 19 | 9 28 | 50 32 | 77250 | 5 | 22750 | 86630 | 8 | 13370 | 09380 | 3 | 90620 | 41 |
| 20 | 7 9 20 | 4 50 40 | 9.77268 | 6 | 10.22732 | 9.86656 | 9 | 10.13344 | 10.09389 | 3 | 9.90611 | 40 |
| 21 | 9 12 | 50 48 | 77285 | 6 | 22715 | 86683 | 9 | 13317 | 09398 | 3 | 90602 | 39 |
| 22 | 9 4 | 50 56 | 77302 | 6 | 22698 | 86709 | 10 | 13291 | 09408 | 3 | 90592 | 38 |
| 23 | 8 56 | 51 4 | 77319 | 7 | 22681 | 86736 | 10 | 13264 | 09417 | 4 | 90583 | 37 |
| 24 | 8 48 | 51 12 | 77336 | 7 | 22664 | 86762 | 11 | 13238 | 09426 | 4 | 90574 | 36 |
| 25 | 7 8 40 | 4 51 20 | 9.77353 | 7 | 10.22647 | 9.86789 | 11 | 10.13211 | 10.09435 | 4 | 9.90565 | 35 |
| 26 | 8 32 | 51 28 | 77370 | 7 | 22630 | 86815 | 11 | 13185 | 09445 | 4 | 90555 | 34 |
| 27 | 8 24 | 51 36 | 77387 | 8 | 22613 | 86842 | 12 | 13158 | 09454 | 4 | 90546 | 33 |
| 28 | 8 16 | 51 44 | 77405 | 8 | 22595 | 86868 | 12 | 13132 | 09463 | 4 | 90537 | 32 |
| 29 | 8 8 | 51 52 | 77422 | 8 | 22578 | 86894 | 13 | 13106 | 09473 | 5 | 90527 | 31 |
| 30 | 7 8 0 | 4 52 0 | 9.77439 | 9 | 10.22561 | 9.86921 | 13 | 10.13079 | 10.09482 | 5 | 9.90518 | 30 |
| 31 | 7 52 | 52 8 | 77456 | 9 | 22544 | 86947 | 14 | 13053 | 09491 | 5 | 90509 | 29 |
| 32 | 7 44 | 52 16 | 77473 | 9 | 22527 | 86974 | 14 | 13026 | 09501 | 5 | 90499 | 28 |
| 33 | 7 36 | 52 24 | 77490 | 9 | 22510 | 87000 | 15 | 13000 | 09510 | 5 | 90490 | 27 |
| 34 | 7 28 | 52 32 | 77507 | 10 | 22493 | 87027 | 15 | 12973 | 09520 | 5 | 90480 | 26 |
| 35 | 7 7 20 | 4 52 40 | 9.77524 | 10 | 10.22476 | 9.87053 | 15 | 10.12947 | 10.09529 | 5 | 9.90471 | 25 |
| 36 | 7 12 | 52 48 | 77541 | 10 | 22459 | 87079 | 16 | 12921 | 09538 | 6 | 90462 | 24 |
| 37 | 7 4 | 52 56 | 77558 | 11 | 22442 | 87106 | 16 | 12894 | 09548 | 6 | 90452 | 23 |
| 38 | 6 56 | 53 4 | 77575 | 11 | 22425 | 87132 | 17 | 12868 | 09557 | 6 | 90443 | 22 |
| 39 | 6 48 | 53 12 | 77592 | 11 | 22408 | 87158 | 17 | 12842 | 09566 | 6 | 90434 | 21 |
| 40 | 7 6 40 | 4 53 20 | 9.77609 | 11 | 10.22391 | 9.87185 | 18 | 10.12815 | 10.09576 | 6 | 9.90424 | 20 |
| 41 | 6 32 | 53 28 | 77626 | 12 | 22374 | 87211 | 18 | 12789 | 09585 | 6 | 90415 | 19 |
| 42 | 6 24 | 53 36 | 77643 | 12 | 22357 | 87238 | 18 | 12762 | 09595 | 7 | 90405 | 18 |
| 43 | 6 16 | 53 44 | 77660 | 12 | 22340 | 87264 | 19 | 12736 | 09604 | 7 | 90396 | 17 |
| 44 | 6 8 | 53 52 | 77677 | 13 | 22323 | 87290 | 19 | 12710 | 09614 | 7 | 90386 | 16 |
| 45 | 7 6 0 | 4 54 0 | 9.77694 | 13 | 10.22306 | 9.87317 | 20 | 10.12683 | 10.09623 | 7 | 9.90377 | 15 |
| 46 | 5 52 | 54 8 | 77711 | 13 | 22289 | 87343 | 20 | 12657 | 09632 | 7 | 90368 | 14 |
| 47 | 5 44 | 54 16 | 77728 | 13 | 22272 | 87369 | 21 | 12631 | 09642 | 7 | 90358 | 13 |
| 48 | 5 36 | 54 24 | 77744 | 14 | 22256 | 87396 | 21 | 12604 | 09651 | 7 | 90349 | 12 |
| 49 | 5 28 | 54 32 | 77761 | 14 | 22239 | 87422 | 22 | 12578 | 09661 | 8 | 90339 | 11 |
| 50 | 7 5 20 | 4 54 40 | 9.77778 | 14 | 10.22222 | 9.87448 | 22 | 10.12552 | 10.09670 | 8 | 9.90330 | 10 |
| 51 | 5 12 | 54 48 | 77795 | 15 | 22205 | 87475 | 22 | 12525 | 09680 | 8 | 90320 | 9 |
| 52 | 5 4 | 54 56 | 77812 | 15 | 22188 | 87501 | 23 | 12499 | 09689 | 8 | 90311 | 8 |
| 53 | 4 56 | 55 4 | 77829 | 15 | 22171 | 87527 | 23 | 12473 | 09699 | 8 | 90301 | 7 |
| 54 | 4 48 | 55 12 | 77846 | 15 | 22154 | 87554 | 24 | 12446 | 09708 | 8 | 90292 | 6 |
| 55 | 7 4 40 | 4 55 20 | 9.77862 | 16 | 10.22138 | 9.87580 | 24 | 10.12420 | 10.09718 | 9 | 9.90282 | 5 |
| 56 | 4 32 | 55 28 | 77879 | 16 | 22121 | 87606 | 25 | 12394 | 09727 | 9 | 90273 | 4 |
| 57 | 4 24 | 55 36 | 77896 | 16 | 22104 | 87633 | 25 | 12367 | 09737 | 9 | 90263 | 3 |
| 58 | 4 16 | 55 44 | 77913 | 16 | 22087 | 87659 | 26 | 12341 | 09746 | 9 | 90254 | 2 |
| 59 | 4 8 | 55 52 | 77930 | 17 | 22070 | 87685 | 26 | 12315 | 09756 | 9 | 90244 | 1 |
| 60 | 4 0 | 56 0 | 77946 | 17 | 22054 | 87711 | 26 | 12289 | 09765 | 9 | 90235 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 126° | | | A | | A | B | | B | C | | C | 53° |

| Seconds of time ....... | 1s | 2s | 3s | 4s | 5s | 6s | 7s |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 2 | 4 | 6 | 9 | 11 | 13 | 15 |
| B | 3 | 7 | 10 | 13 | 17 | 20 | 23 |
| C | 1 | 2 | 4 | 5 | 6 | 7 | 8 |

TABLE 44.     [Page 645

Log. Sines, Tangents, and Secants.

37°      A      A      B      B      C      C      142°

| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 7 4 0 | 4 56 0 | 9.77946 | 0 | 10.22054 | 9.87711 | 0 | 10.12289 | 10.09765 | 0 | 9.90235 | 60 |
| 1 | 3 52 | 56 8 | 77963 | 0 | 22037 | 87738 | 0 | 12262 | 09775 | 0 | 90225 | 59 |
| 2 | 3 44 | 56 16 | 77980 | 1 | 22020 | 87764 | 1 | 12236 | 09784 | 0 | 90216 | 58 |
| 3 | 3 36 | 56 24 | 77997 | 1 | 22003 | 87790 | 1 | 12210 | 09794 | 0 | 90206 | 57 |
| 4 | 3 28 | 56 32 | 78013 | 1 | 21987 | 87817 | 2 | 12183 | 09803 | 1 | 90197 | 56 |
| 5 | 7 3 20 | 4 56 40 | 9.78030 | 1 | 10.21970 | 9.87843 | 2 | 10.12157 | 10.09813 | 1 | 9.90187 | 55 |
| 6 | 3 12 | 56 48 | 78047 | 2 | 21953 | 87869 | 3 | .12131 | 09822 | 1 | 90178 | 54 |
| 7 | 3 4 | 56 56 | 78063 | 2 | 21937 | 87895 | 3 | 12105 | 09832 | 1 | 90168 | 53 |
| 8 | 2 56 | 57 4 | 78080 | 2 | 21920 | 87922 | 3 | 12078 | 09841 | 1 | 90159 | 52 |
| 9 | 2 48 | 57 12 | 78097 | 2 | 21903 | 87948 | 4 | 12052 | 09851 | 1 | 90149 | 51 |
| 10 | 7 2 40 | 4 57 20 | 9.78113 | 3 | 10.21887 | 9.87974 | 4 | 10.12026 | 10.09861 | 2 | 9.90139 | 50 |
| 11 | 2 32 | 57 28 | 78130 | 3 | 21870 | 88000 | 5 | 12000 | 09870 | 2 | 90130 | 49 |
| 12 | 2 24 | 57 36 | 78147 | 3 | 21853 | 88027 | 5 | 11973 | 09880 | 2 | 90120 | 48 |
| 13 | 2 16 | 57 44 | 78163 | 4 | 21837 | 88053 | 6 | 11947 | 09889 | 2 | 90111 | 47 |
| 14 | 2 8 | 57 52 | 78180 | 4 | 21820 | 88079 | 6 | 11921 | 09899 | 2 | 90101 | 46 |
| 15 | 7 2 0 | 4 58 0 | 9.78197 | 4 | 10.21803 | 9.88105 | 7 | 10.11895 | 10.09909 | 2 | 9.90091 | 45 |
| 16 | 1 52 | 58 8 | 78213 | 4 | 21787 | 88131 | 7 | 11869 | 09918 | 3 | 90082 | 44 |
| 17 | 1 44 | 58 16 | 78230 | 5 | 21770 | 88158 | 7 | 11842 | 09928 | 3 | 90072 | 43 |
| 18 | 1 36 | 58 24 | 78246 | 5 | 21754 | 88184 | 8 | 11816 | 09937 | 3 | 90063 | 42 |
| 19 | 1 28 | 58 32 | 78263 | 5 | 21737 | 88210 | 8 | 11790 | 09947 | 3 | 90053 | 41 |
| 20 | 7 1 20 | 4 58 40 | 9.78280 | 5 | 10.21720 | 9.88236 | 9 | 10.11764 | 10.09957 | 3 | 9.90043 | 40 |
| 21 | 1 12 | 58 48 | 78296 | 6 | 21704 | 88262 | 9 | 11738 | 09966 | 3 | 90034 | 39 |
| 22 | 1 4 | 58 56 | 78313 | 6 | 21687 | 88289 | 10 | 11711 | 09976 | 4 | 90024 | 38 |
| 23 | 0 56 | 59 4 | 78329 | 6 | 21671 | 88315 | 10 | 11685 | 09986 | 4 | 90014 | 37 |
| 24 | 0 48 | 59 12 | 78346 | 7 | 21654 | 88341 | 10 | 11659 | 09995 | 4 | 90005 | 36 |
| 25 | 7 0 40 | 4 59 20 | 9.78362 | 7 | 10.21638 | 9.88367 | 11 | 10.11633 | 10.10005 | 4 | 9.89995 | 35 |
| 26 | 0 32 | 59 28 | 78379 | 7 | 21621 | 88393 | 11 | 11607 | 10015 | 4 | 89985 | 34 |
| 27 | 0 24 | 59 36 | 78395 | 7 | 21605 | 88420 | 12 | 11580 | 10024 | 4 | 89976 | 33 |
| 28 | 0 16 | 59 44 | 78412 | 8 | 21588 | 88446 | 12 | 11554 | 10034 | 5 | 89966 | 32 |
| 29 | 0 8 | 59 52 | 78428 | 8 | 21572 | 88472 | 13 | 11528 | 10044 | 5 | 89956 | 31 |
| 30 | 7 0 0 | 5 0 0 | 9.78445 | 8 | 10.21555 | 9.88498 | 13 | 10.11502 | 10.10053 | 5 | 9.89947 | 30 |
| 31 | 6 59 52 | 0 8 | 78461 | 9 | 21539 | 88524 | 14 | 11476 | 10063 | 5 | 89937 | 29 |
| 32 | 59 44 | 0 16 | 78478 | 9 | 21522 | 88550 | 14 | 11450 | 10073 | 5 | 89927 | 28 |
| 33 | 59 36 | 0 24 | 78494 | 9 | 21506 | 88577 | 14 | 11423 | 10082 | 5 | 89918 | 27 |
| 34 | 59 28 | 0 32 | 78510 | 9 | 21490 | 88603 | 15 | 11397 | 10092 | 5 | 89908 | 26 |
| 35 | 6 59 20 | 5 0 40 | 9.78527 | 10 | 10.21473 | 9.88629 | 15 | 10.11371 | 10.10102 | 6 | 9.89898 | 25 |
| 36 | 59 12 | 0 48 | 78543 | 10 | 21457 | 88655 | 16 | 11345 | 10112 | 6 | 89888 | 24 |
| 37 | 59 4 | 0 56 | 78560 | 10 | 21440 | 88681 | 16 | 11319 | 10121 | 6 | 89879 | 23 |
| 38 | 58 56 | 1 4 | 78576 | 10 | 21424 | 88707 | 17 | 11293 | 10131 | 6 | 89869 | 22 |
| 39 | 58 48 | 1 12 | 78592 | 11 | 21408 | 88733 | 17 | 11267 | 10141 | 6 | 89859 | 21 |
| 40 | 6 58 40 | 5 1 20 | 9.78609 | 11 | 10.21391 | 9.88759 | 17 | 10.11241 | 10.10151 | 6 | 9.89849 | 20 |
| 41 | 58 32 | 1 28 | 78625 | 11 | 21375 | 88786 | 18 | 11214 | 10160 | 7 | 89840 | 19 |
| 42 | 58 24 | 1 36 | 78642 | 12 | 21358 | 88812 | 18 | 11188 | 10170 | 7 | 89830 | 18 |
| 43 | 58 16 | 1 44 | 78658 | 12 | 21342 | 88838 | 19 | 11162 | 10180 | 7 | 89820 | 17 |
| 44 | 58 8 | 1 52 | 78674 | 12 | 21326 | 88864 | 19 | 11136 | 10190 | 7 | 89810 | 16 |
| 45 | 6 58 0 | 5 2 0 | 9.78691 | 12 | 10.21309 | 9.88890 | 20 | 10.11110 | 10.10199 | 7 | 9.89801 | 15 |
| 46 | 57 52 | 2 8 | 78707 | 13 | 21293 | 88916 | 20 | 11084 | 10209 | 7 | 89791 | 14 |
| 47 | 57 44 | 2 16 | 78723 | 13 | 21277 | 88942 | 20 | 11058 | 10219 | 8 | 89781 | 13 |
| 48 | 57 36 | 2 24 | 78739 | 13 | 21261 | 88968 | 21 | 11032 | 10229 | 8 | 89771 | 12 |
| 49 | 57 28 | 2 32 | 78756 | 13 | 21244 | 88994 | 21 | 11006 | 10239 | 8 | 89761 | 11 |
| 50 | 6 57 20 | 5 2 40 | 9.78772 | 14 | 10.21228 | 9.89020 | 22 | 10.10980 | 10.10248 | 8 | 9.89752 | 10 |
| 51 | 57 12 | 2 48 | 78788 | 14 | 21212 | 89046 | 22 | 10954 | 10258 | 8 | 89742 | 9 |
| 52 | 57 4 | 2 56 | 78805 | 14 | 21195 | 89073 | 23 | 10927 | 10268 | 8 | 89732 | 8 |
| 53 | 56 56 | 3 4 | 78821 | 15 | 21179 | 89099 | 23 | 10901 | 10278 | 9 | 89722 | 7 |
| 54 | 56 48 | 3 12 | 78837 | 15 | 21163 | 89125 | 24 | 10875 | 10288 | 9 | 89712 | 6 |
| 55 | 6 56 40 | 5 3 20 | 9.78853 | 15 | 10.21147 | 9.89151 | 24 | 10.10849 | 10.10298 | 9 | 9.89702 | 5 |
| 56 | 56 32 | 3 28 | 78869 | 15 | 21131 | 89177 | 24 | 10823 | 10307 | 9 | 89693 | 4 |
| 57 | 56 24 | 3 36 | 78886 | 16 | 21114 | 89203 | 25 | 10797 | 10317 | 9 | 89683 | 3 |
| 58 | 56 16 | 3 44 | 78902 | 16 | 21098 | 89229 | 25 | 10771 | 10327 | 9 | 89673 | 2 |
| 59 | 56 8 | 3 52 | 78918 | 16 | 21082 | 89255 | 26 | 10745 | 10337 | 10 | 89663 | 1 |
| 60 | 56 0 | 4 0 | 78934 | 16 | 21066 | 89281 | 26 | 10719 | 10347 | 10 | 89653 | 0 |

| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

127°      A      A      B      B      C      C      52°

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| B | 3 | 7 | 10 | 13 | 16 | 20 | 23 |
| C | 1 | 2 | 4 | 5 | 6 | 7 | 8 |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

38°         A      A    B      B    C      C   141°

| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6 56 0 | 5 4 0 | 9.78934 | 0 | 10.21066 | 9.89281 | 0 | 10.10719 | 10.10347 | 0 | 9.89653 | 60 |
| 1 | 55 52 | 4 8 | 78950 | 0 | 21050 | 89307 | 0 | 10693 | 10357 | 0 | 89643 | 59 |
| 2 | 55 44 | 4 16 | 78967 | 1 | 21033 | 89333 | 1 | 10667 | 10367 | 0 | 89633 | 58 |
| 3 | 55 36 | 4 24 | 78983 | 1 | 21017 | 89359 | 1 | 10641 | 10376 | 1 | 89624 | 57 |
| 4 | 55 28 | 4 32 | 78999 | 1 | 21001 | 89385 | 2 | 10615 | 10386 | 1 | 89614 | 56 |
| 5 | 6 55 20 | 5 4 40 | 9.79015 | 1 | 10.20985 | 9.89411 | 2 | 10.10589 | 10.10396 | 1 | 9.89604 | 55 |
| 6 | 55 12 | 4 48 | 79031 | 2 | 20969 | 89437 | 3 | 10563 | 10406 | 1 | 89594 | 54 |
| 7 | 55 4 | 4 56 | 79047 | 2 | 20953 | 89463 | 3 | 10537 | 10416 | ·1 | 89584 | 53 |
| 8 | 54 56 | 5 4 | 79063 | 2 | 20937 | 89489 | 3 | 10511 | 10426 | 1 | 89574 | 52 |
| 9 | 54 48 | 5 12 | 79079 | 2 | 20921 | 89515 | 4 | 10485 | 10436 | 2 | 89564 | 51 |
| 10 | 6 54 40 | 5 5 20 | 9.79095 | 3 | 10.20905 | 9.89541 | 4 | 10.10459 | 10.10446 | 2 | 9.89554 | 50 |
| 11 | 54 32 | 5 28 | 79111 | 3 | 20889 | 89567 | 5 | 10433 | 10456 | 2 | 89544 | 49 |
| 12 | 54 24 | 5 36 | 79128 | 3 | 20872 | 89593 | 5 | 10407 | 10466 | 2 | 89534 | 48 |
| 13 | 54 16 | 5 44 | 79144 | 3 | 20856 | 89619 | 6 | 10381 | 10476 | 2 | 89524 | 47 |
| 14 | 54 8 | 5 52 | 79160 | 4 | 20840 | 89645 | 6 | 10355 | 10486 | 2 | 89514 | 46 |
| 15 | 6 54 0 | 5 6 0 | 9.79176 | 4 | 10.20824 | 9.89671 | 6 | 10.10329 | 10.10496 | 3 | 9.89504 | 45 |
| 16 | 53 52 | 6 8 | 79192 | 4 | 20808 | 89697 | 7 | 10303 | 10505 | 3 | 89495 | 44 |
| 17 | 53 44 | 6 16 | 79208 | 5 | 20792 | 89723 | 7 | 10277 | 10515 | 3 | 89485 | 43 |
| 18 | 53 36 | 6 24 | 79224 | 5 | 20776 | 89749 | 8 | 10251 | 10525 | 3 | 89475 | 42 |
| 19 | 53 28 | 6 32 | 79240 | 5 | 20760 | 89775 | 8 | 10225 | 10535 | 3 | 89465 | 41 |
| 20 | 6 53 20 | 5 6 40 | 9.79256 | 5 | 10.20744 | 9.89801 | 9 | 10.10199 | 10.10545 | 3 | 9.89455 | 40 |
| 21 | 53 12 | 6 48 | 79272 | 6 | 20728 | 89827 | 9 | 10173 | 10555 | 4 | 89445 | 39 |
| 22 | 53 4 | 6 56 | 79288 | 6 | 20712 | 89853 | 10 | 10147 | 10565 | 4 | 89435 | 38 |
| 23 | 52 56 | 7 4 | 79304 | 6 | 20696 | 89879 | 10 | 10121 | 10575 | 4 | 89425 | 37 |
| 24 | 52 48 | 7 12 | 79319 | 6 | 20681 | 89905 | 10 | 10095 | 10585 | 4 | 89415 | 36 |
| 25 | 6 52 40 | 5 7 20 | 9.79335 | 7 | 10.20665 | 9.89931 | 11 | 10.10069 | 10.10595 | 4 | 9.89405 | 35 |
| 26 | 52 32 | 7 28 | 79351 | 7 | 20649 | 89957 | 11 | 10043 | 10605 | 4 | 89395 | 34 |
| 27 | 52 24 | 7 36 | 79367 | 7 | 20633 | 89983 | 12 | 10017 | 10615 | 5 | 89385 | 33 |
| 28 | 52 16 | 7 44 | 79383 | 7 | 20617 | 90009 | 12 | 09991 | 10625 | 5 | 89375 | 32 |
| 29 | 52 8 | 7 52 | 79399 | 8 | 20601 | 90035 | 13 | 09965 | 10636 | 5 | 89364 | 31 |
| 30 | 6 52 0 | 5 8 0 | 9.79415 | 8 | 10.20585 | 9.90061 | 13 | 10.09939 | 10.10646 | 5 | 9.89354 | 30 |
| 31 | 51 52 | 8 8 | 79431 | 8 | 20569 | 90086 | 13 | 09914 | 10656 | 5 | 89344 | 29 |
| 32 | 51 44 | 8 16 | 79447 | 8 | 20553 | 90112 | 14 | 09888 | 10666 | 5 | 89334 | 28 |
| 33 | 51 36 | 8 24 | 79463 | 9 | 20537 | 90138 | 14 | 09862 | 10676 | 6 | 89324 | 27 |
| 34 | 51 28 | 8 32 | 79478 | 9 | 20522 | 90164 | 15 | 09836 | 10686 | 6 | 89314 | 26 |
| 35 | 6 51 20 | 5 8 40 | 9.79494 | 9 | 10.20506 | 9.90190 | 15 | 10.09810 | 10.10696 | 6 | 9.89304 | 25 |
| 36 | 51 12 | 8 48 | 79510 | 10 | 20490 | 90216 | 16 | 09784 | 10706 | 6 | 89294 | 24 |
| 37 | 51 4 | 8 56 | 79526 | 10 | 20474 | 90242 | 16 | 09758 | 10716 | 6 | 89284 | 23 |
| 38 | 50 56 | 9 4 | 79542 | 10 | 20458 | 90268 | 16 | 09732 | 10726 | 6 | 89274 | 22 |
| 39 | 50 48 | 9 12 | 79558 | 10 | 20442 | 90294 | 17 | 09706 | 10736 | 7 | 89264 | 21 |
| 40 | 6 50 40 | 5 9 20 | 9.79573 | 11 | 10.20427 | 9.90320 | 17 | 10.09680 | 10.10746 | 7 | 9.89254 | 20 |
| 41 | 50 32 | 9 28 | 79589 | 11 | 20411 | 90346 | 18 | 09654 | 10756 | 7 | 89244 | 19 |
| 42 | 50 24 | 9 36 | 79605 | 11 | 20395 | 90371 | 18 | 09629 | 10767 | 7 | 89233 | 18 |
| 43 | 50 16 | 9 44 | 79621 | 11 | 20379 | 90397 | 19 | 09603 | 10777 | 7 | 89223 | 17 |
| 44 | 50 8 | 9 52 | 79636 | 12 | 20364 | 90423 | 19 | 09577 | 10787 | 7 | 89213 | 16 |
| 45 | 6 50 0 | 5 10 0 | 9.79652 | 12 | 10.20348 | 9.90449 | 19 | 10.09551 | 10.10797 | 8 | 9.89203 | 15 |
| 46 | 49 52 | 10 8 | 79668 | 12 | 20332 | 90475 | 20 | 09525 | 10807 | 8 | 89193 | 14 |
| 47 | 49 44 | 10 16 | 79684 | 12 | 20316 | 90501 | 20 | 09499 | 10817 | 8 | 89183 | 13 |
| 48 | 49 36 | 10 24 | 79699 | 13 | 20301 | 90527 | 21 | 09473 | 10827 | 8 | 89173 | 12 |
| 49 | 49 28 | 10 32 | 79715 | 13 | 20285 | 90553 | 21 | 09447 | 10838 | 8 | 89162 | 11 |
| 50 | 6 49 20 | 5 10 40 | 9.79731 | 13 | 10.20269 | 9.90578 | 22 | 10.09422 | 10.10848 | 8 | 9.89152 | 10 |
| 51 | 49 12 | 10 48 | 79746 | 14 | 20254 | 90604 | 22 | 09396 | 10858 | 9 | 89142 | 9 |
| 52 | 49 4 | 10 56 | 79762 | 14 | 20238 | 90630 | 22 | 09370 | 10868 | 9 | 89132 | 8 |
| 53 | 48 56 | 11 4 | 79778 | 14 | 20222 | 90656 | 23 | 09344 | 10878 | 9 | 89122 | 7 |
| 54 | 48 48 | 11 12 | 79793 | 14 | 20207 | 90682 | 23 | 09318 | 10888 | 9 | 89112 | 6 |
| 55 | 6 48 40 | 5 11 20 | 9.79809 | 15 | 10.20191 | 9.90708 | 24 | 10.09292 | 10.10899 | 9 | 9.89101 | 5 |
| 56 | 48 32 | 11 28 | 79825 | 15 | 20175 | 90734 | 24 | 09266 | 10909 | 9 | 89091 | 4 |
| 57 | 48 24 | 11 36 | 79840 | 15 | 20160 | 90759 | 25 | 09241 | 10919 | 10 | 89081 | 3 |
| 58 | 48 16 | 11 44 | 79856 | 15 | 20144 | 90785 | 25 | 09215 | 10929 | 10 | 89071 | 2 |
| 59 | 48 8 | 11 52 | 79872 | 16 | 20128 | 90811 | 26 | 09189 | 10940 | 10 | 89060 | 1 |
| 60 | 48 0 | 12 0 | 79887 | 16 | 20113 | 90837 | 26 | 09163 | 10950 | 10 | 89050 | 0 |

| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

128°         A      A    B      B    C      C   51°

| Seconds of time ....... | | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|---|
| Prop. parts of cols. | A | 2 | 4 | ·6 | 8 | 10 | 12 | 14 |
| | B | 3 | 6 | 10 | 13 | 16 | 19 | 23 |
| | C | 1 | 3 | 4 | 5 | 6 | 8 | 9 |

TABLE 44. [Page 647

Log. Sines, Tangents, and Secants.

39°  A  A  B  B  C  C  140°

| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6 48 0 | 5 12 0 | 9. 79887 | 0 | 10. 20113 | 9. 90837 | 0 | 10. 09163 | 10. 10950 | 0 | 9. 89050 | 60 |
| 1 | 47 52 | 12 8 | 79903 | 0 | 20097 | 90863 | 0 | 09137 | 10960 | 0 | 89040 | 59 |
| 2 | 47 44 | 12 16 | 79918 | 1 | 20082 | 90889 | 1 | 09111 | 10970 | 0 | 89030 | 58 |
| 3 | 47 36 | 12 24 | 79934 | 1 | 20066 | 90914 | 1 | 09086 | 10980 | 1 | 89020 | 57 |
| 4 | 47 28 | 12 32 | 79950 | 1 | 20050 | 90940 | 2 | 09060 | 10991 | 1 | 89009 | 56 |
| 5 | 6 47 20 | 5 12 40 | 9. 79965 | 1 | 10. 20035 | 9. 90966 | 2 | 10. 09034 | 10. 11001 | 1 | 9. 88999 | 55 |
| 6 | · 47 12 | 12 48 | 79981 | 2 | 20019 | 90992 | 3 | 09008 | 11011 | 1 | 88989 | 54 |
| 7 | 47 4 | 12 56 | 79996 | 2 | 20004 | 91018 | 3 | 08982 | 11022 | 1 | 88978 | 53 |
| 8 | 46 56 | 13 4 | 80012 | 2 | 19988 | 91043 | 3 | 08957 | 11032 | 1 | 88968 | 52 |
| 9 | 46 48 | 13 12 | 80027 | 2 | 19973 | 91069 | 4 | 08931 | 11042 | 2 | 88958 | 51 |
| 10 | 6 46 40 | 5 13 20 | 9. 80043 | 3 | 10. 19957 | 9. 91095 | 4 | 10. 08905 | 10. 11052 | 2 | 9. 88948 | 50 |
| 11 | 46 32 | 13 28 | 80058 | 3 | 19942 | 91121 | 5 | 08879 | 11063 | 2 | 88937 | 49 |
| 12 | 46 24 | 13 36 | 80074 | 3 | 19926 | 91147 | 5 | 08853 | 11073 | 2 | 88927 | 48 |
| 13 | 46 16 | 13 44 | 80089 | 3 | 19911 | 91172 | 6 | 08828 | 11083 | 2 | 88917 | 47 |
| 14 | 46 8 | 13 52 | 80105 | 4 | 19895 | 91198 | 6 | 08802 | 11094 | 2 | 88906 | 46 |
| 15 | 6 46 0 | 5 14 0 | 9. 80120 | 4 | 10. 19880 | 9. 91224 | 6 | 10. 08776 | 10. 11104 | 3 | 9. 88896 | 45 |
| 16 | 45 52 | 14 8 | 80136 | 4 | 19864 | 91250 | 7 | 08750 | 11114 | 3 | 88886 | 44 |
| 17 | 45 44 | 14 16 | 80151 | 4 | 19849 | 91276 | 7 | 08724 | 11125 | 3 | 88875 | 43 |
| 18 | 45 36 | 14 24 | 80166 | 5 | 19834 | 91301 | 8 | 08699 | 11135 | 3 | 88865 | 42 |
| 19 | 45 28 | 14 32 | 80182 | 5 | 19818 | 91327 | 8 | 08673 | 11145 | 3 | 88855 | 41 |
| 20 | 6 45 20 | 5 14 40 | 9. 80197 | 5 | 10. 19803 | 9. 91353 | 9 | 10. 08647 | 10. 11156 | 3 | 9. 88844 | 40 |
| 21 | 45 12 | 14 48 | 80213 | 5 | 19787 | 91379 | 9 | 08621 | 11166 | 4 | 88834 | 39 |
| 22 | 45 4 | 14 56 | 80228 | 6 | 19772 | 91404 | 9 | 08596 | 11176 | 4 | 88824 | 38 |
| 23 | 44 56 | 15 4 | 80244 | 6 | 19756 | 91430 | 10 | 08570 | 11187 | 4 | 88813 | 37 |
| 24 | 44 48 | 15 12 | 80259 | 6 | 19741 | 91456 | 10 | 08544 | 11197 | 4 | 88803 | 36 |
| 25 | 6 44 40 | 5 15 20 | 9. 80274 | 6 | 10. 19726 | 9. 91482 | 11 | 10. 08518 | 10. 11207 | 4 | 9. 88793 | 35 |
| 26 | 44 32 | 15 28 | 80290 | 7 | 19710 | 91507 | 11 | 08493 | 11218 | 5 | 88782 | 34 |
| 27 | 44 24 | 15 36 | 80305 | 7 | 19695 | 91533 | 12 | 08467 | 11228 | 5 | 88772 | 33 |
| 28 | 44 16 | 15 44 | 80320 | 7 | 19680 | 91559 | 12 | 08441 | 11239 | 5 | 88761 | 32 |
| 29 | 44 8 | 15 52 | 80336 | 7 | 19664 | 91585 | 12 | 08415 | 11249 | 5 | 88751 | 31 |
| 30 | 6 44 0 | 5 16 0 | 9. 80351 | 8 | 10. 19649 | 9. 91610 | 13 | 10. 08390 | 10. 11259 | 5 | 9. 88741 | 30 |
| 31 | 43 52 | 16 8 | 80366 | 8 | 19634 | 91636 | 13 | 08364 | 11270 | 5 | 88730 | 29 |
| 32 | 43 44 | 16 16 | 80382 | 8 | 19618 | 91662 | 14 | 08338 | 11280 | 6 | 88720 | 28 |
| 33 | 43 36 | 16 24 | 80397 | 8 | 19603 | 91688 | 14 | 08312 | 11291 | 6 | 88709 | 27 |
| 34 | 43 28 | 16 32 | 80412 | 9 | 19588 | 91713 | 15 | 08287 | 11301 | 6 | 88699 | 26 |
| 35 | 6 43 20 | 5 16 40 | 9. 80428 | 9 | 10. 19572 | 9. 91739 | 15 | 10. 08261 | 10. 11312 | 6 | 9. 88688 | 25 |
| 36 | 43 12 | 16 48 | 80443 | 9 | 19557 | 91765 | 15 | 08235 | 11322 | 6 | 88678 | 24 |
| 37 | 43 4 | 16 56 | 80458 | 9 | 19542 | 91791 | 16 | 08209 | 11332 | 6 | 88668 | 23 |
| 38 | 42 56 | 17 4 | 80473 | 10 | 19527 | 91816 | 16 | 08184 | 11343 | 7 | 88657 | 22 |
| 39 | 42 48 | 17 12 | 80489 | 10 | 19511 | 91842 | 17 | 08158 | 11353 | 7 | 88647 | 21 |
| 40 | 6 42 40 | 5 17 20 | 9. 80504 | 10 | 10. 19496 | 9. 91868 | 17 | 10. 08132 | 10. 11364 | 7 | 9. 88636 | 20 |
| 41 | 42 32 | 17 28 | 80519 | 10 | 19481 | 91893 | 18 | 08107 | 11374 | 7 | 88626 | 19 |
| 42 | 42 24 | 17 36 | 80534 | 11 | 19466 | 91919 | 18 | 08081 | 11385 | 7 | 88615 | 18 |
| 43 | 42 16 | 17 44 | 80550 | 11 | 19450 | 91945 | 18 | 08055 | 11395 | 7 | 88605 | 17 |
| 44 | 42 8 | 17 52 | 80565 | 11 | 19435 | 91971 | 19 | 08029 | 11406 | 8 | 88594 | 16 |
| 45 | 6 42 0 | 5 18 0 | 9. 80580 | 12 | 10. 19420 | 9. 91996 | 19 | 10. 08004 | 10. 11416 | 8 | 9. 88584 | 15 |
| 46 | 41 52 | 18 8 | 80595 | 12 | 19405 | 92022 | 20 | 07978 | 11427 | 8 | 88573 | 14 |
| 47 | 41 44 | 18 16 | 80610 | 12 | 19390 | 92048 | 20 | 07952 | 11437 | 8 | 88563 | 13 |
| 48 | 41 36 | 18 24 | 80625 | 12 | 19375 | 92073 | 21 | 07927 | 11448 | 8 | 88552 | 12 |
| 49 | 41 28 | 18 32 | 80641 | 13 | 19359 | 92099 | 21 | .07901 | 11458 | 9 | 88542 | 11 |
| 50 | 6 41 20 | 5 18 40 | 9. 80656 | 13 | 10. 19344 | 9. 92125 | 21 | 10. 07875 | 10. 11469 | 9 | 9. 88531 | 10 |
| 51 | 41 12 | 18 48 | 80671 | 13 | 19329 | 92150 | 22 | 07850 | 11479 | 9 | 88521 | 9 |
| 52 | 41 4 | 18 56 | 80686 | 13 | 19314 | 92176 | 22 | 07824 | 11490 | 9 | 88510 | 8 |
| 53 | 40 56 | 19 4 | 80701 | 14 | 19299 | 92202 | 23 | 07798 | 11501 | 9 | 88499 | 7 |
| 54 | 40 48 | 19 12 | 80716 | 14 | 19284 | 92227 | 23 | 07773 | 11511 | 9 | 88489 | 6 |
| 55 | 6 40 40 | 5 19 20 | 9. 80731 | 14 | 10. 19269 | 9. 92253 | 24 | 10. 07747 | 10. 11522 | 10 | 9. 88478 | 5 |
| 56 | 40 32 | 19 28 | 80746 | 14 | 19254 | 92279 | 24 | 07721 | 11532 | 10 | 88468 | 4 |
| 57 | 40 24 | 19 36 | 80762 | 15 | 19238 | 92304 | 24 | 07696 | 11543 | 10 | 88457 | 3 |
| 58 | 40 16 | 19 44 | 80777 | 15 | 19223 | 92330 | 25 | 07670 | 11553 | 10 | 88447 | 2 |
| 59 | 40 8 | 19 52 | 80792 | 15 | 19208 | 92356 | 25 | 07644 | 11564 | 10 | 88436 | 1 |
| 60 | 40 0 | 20 0 | 80807 | 15 | 19193 | 92381 | 26 | 07619 | 11575 | 10 | 88425 | 0 |

| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

129°  A  A  B  B  C  C  50°

| Seconds of time....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 2 | 4 | 6 | 8 | 10 | 12 | 13 |
| B | 3 | 6 | 10 | 13 | 16 | 19 | 23 |
| C | 1 | 3 | 4 | 5 | 7 | 8 | 9 |

# TABLE 44.

### Log. Sines, Tangents, and Secants.

| 40° | | | A | | A | B | | B | C | | C | 139° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 6 40 0 | 5 20 0 | 9.80807 | 0 | 10.19193 | 9.92381 | 0 | 10.07619 | 10.11575 | 0 | 9.88425 | 60 |
| 1 | 39 52 | 20 8 | 80822 | 0 | 19178 | 92407 | 0 | 07593 | 11585 | 0 | 88415 | 59 |
| 2 | 39 44 | 20 16 | 80837 | 0 | 19163 | 92433 | 1 | 07567 | 11596 | 0 | 88404 | 58 |
| 3 | 39 36 | 20 24 | 80852 | 1 | 19148 | 92458 | 1 | 07542 | 11606 | 1 | 88394 | 57 |
| 4 | 39 28 | 20 32 | 80867 | 1 | 19133 | 92484 | 2 | 07516 | 11617 | 1 | 88383 | 56 |
| 5 | 6 39 20 | 5 20 40 | 9.80882 | 1 | 10.19118 | 9.92510 | 2 | 10.07490 | 10.11628 | 1 | 9.88372 | 55 |
| 6 | 39 12 | 20 48 | 80897 | 1 | 19103 | 92535 | 3 | 07465 | 11638 | 1 | 88362 | 54 |
| 7 | 39 4 | 20 56 | 80912 | 2 | 19088 | 92561 | 3 | 07439 | 11649 | 1 | 88351 | 53 |
| 8 | 38 56 | 21 4 | 80927 | 2 | 19073 | 92587 | 3 | 07413 | 11660 | 1 | 88340 | 52 |
| 9 | 38 48 | 21 12 | 80942 | 2 | 19058 | 92612 | 4 | 07388 | 11670 | 2 | 88330 | 51 |
| 10 | 6 38 40 | 5 21 20 | 9.80957 | 2 | 10.19043 | 9.92638 | 4 | 10.07362 | 10.11681 | 2 | 9.88319 | 50 |
| 11 | 38 32 | 21 28 | 80972 | 3 | 19028 | 92663 | 5 | 07337 | 11692 | 2 | 88308 | 49 |
| 12 | 38 24 | 21 36 | 80987 | 3 | 19013 | 92689 | 5 | 07311 | 11702 | 2 | 88298 | 48 |
| 13 | 38 16 | 21 44 | 81002 | 3 | 18998 | 92715 | 6 | 07285 | 11713 | 2 | 88287 | 47 |
| 14 | 38 8 | 21 52 | 81017 | 3 | 18983 | 92740 | 6 | 07260 | 11724 | 3 | 88276 | 46 |
| 15 | 6 38 0 | 5 22 0 | 9.81032 | 4 | 10.18968 | 9.92766 | 6 | 10.07234 | 10.11734 | 3 | 9.88266 | 45 |
| 16 | 37 52 | 22 8 | 81047 | 4 | 18953 | 92792 | 7 | 07208 | 11745 | 3 | 88255 | 44 |
| 17 | 37 44 | 22 16 | 81061 | 4 | 18939 | 92817 | 7 | 07183 | 11756 | 3 | 88244 | 43 |
| 18 | 37 36 | 22 24 | 81076 | 4 | 18924 | 92843 | 8 | 07157 | 11766 | 3 | 88234 | 42 |
| 19 | 37 28 | 22 32 | 81091 | 5 | 18909 | 92868 | 8 | 07132 | 11777 | 3 | 88223 | 41 |
| 20 | 6 37 20 | 5 22 40 | 9.81106 | 5 | 10.18894 | 9.92894 | 9 | 10.07106 | 10.11788 | 4 | 9.88212 | 40 |
| 21 | 37 12 | 22 48 | 81121 | 5 | 18879 | 92920 | 9 | 07080 | 11799 | 4 | 88201 | 39 |
| 22 | 37 4 | 22 56 | 81136 | 5 | 18864 | 92945 | 9 | 07055 | 11809 | 4 | 88191 | 38 |
| 23 | 36 56 | 23 4 | 81151 | 6 | 18849 | 92971 | 10 | 07029 | 11820 | 4 | 88180 | 37 |
| 24 | 36 48 | 23 12 | 81166 | 6 | 18834 | 92996 | 10 | 07004 | 11831 | 4 | 88169 | 36 |
| 25 | 6 36 40 | 5 23 20 | 9.81180 | 6 | 10.18820 | 9.93022 | 11 | 10.06978 | 10.11842 | 4 | 9.88158 | 35 |
| 26 | 36 32 | 23 28 | 81195 | 6 | 18805 | 93048 | 11 | 06952 | 11852 | 5 | 88148 | 34 |
| 27 | 36 24 | 23 36 | 81210 | 7 | 18790 | 93073 | 12 | 06927 | 11863 | 5 | 88137 | 33 |
| 28 | 36 16 | 23 44 | 81225 | 7 | 18775 | 93099 | 12 | 06901 | · 11874 | 5 | 88126 | 32 |
| 29 | 36 8 | 23 52 | 81240 | 7 | 18760 | 93124 | 12 | 06876 | 11885 | 5 | 88115 | 31 |
| 30 | 6 36 0 | 5 24 0 | 9.81254 | 7 | 10.18746 | 9.93150 | 13 | 10.06850 | 10.11895 | 5 | 9.88105 | 30 |
| 31 | 35 52 | 24 8 | 81269 | 8 | 18731 | 93175 | 13 | 06825 | 11906 | 6 | 88094 | 29 |
| 32 | 35 44 | 24 16 | 81284 | 8 | 18716 | 93201 | 14 | 06799 | 11917 | 6 | 88083 | 28 |
| 33 | 35 36 | 24 24 | 81299 | 8 | 18701 | 93227 | 14 | 06773 | 11928 | 6 | 88072 | 27 |
| 34 | 35 28 | 24 32 | 81314 | 8 | 18686 | 93252 | 14 | 06748 | 11939 | 6 | 88061 | 26 |
| 35 | 6 35 20 | 5 24 40 | 9.81328 | 9 | 10.18672 | 9.93278 | 15 | 10.06722 | 10.11949 | 6 | 9.88051 | 25 |
| 36 | 35 12 | 24 48 | 81343 | 9 | 18657 | 93303 | 15 | 06697 | 11960 | 6 | 88040 | 24 |
| 37 | 35 4 | 24 56 | 81358 | 9 | 18642 | 93329 | 16 | 06671 | 11971 | 7 | 88029 | 23 |
| 38 | 34 56 | 25 4 | 81372 | 9 | 18628 | 93354 | 16 | 06646 | 11982 | 7 | 88018 | 22 |
| 39 | 34 48 | 25 12 | 81387 | 10 | 18613 | 93380 | 17 | 06620 | 11993 | 7 | 88007 | 21 |
| 40 | 6 34 40 | 5 25 20 | 9.81402 | 10 | 10.18598 | 9.93406 | 17 | 10.06594 | 10.12004 | 7 | 9.87996 | 20 |
| 41 | 34 32 | 25 28 | 81417 | 10 | 18583 | 93431 | 17 | 06569 | 12015 | 7 | 87985 | 19 |
| 42 | 34 24 | 25 36 | 81431 | 10 | 18569 | 93457 | 18 | 06543 | 12025 | 8 | 87975 | 18 |
| 43 | 34 16 | 25 44 | 81446 | 11 | 18554 | 93482 | 18 | 06518 | 12036 | 8 | 87964 | 17 |
| 44 | 34 8 | 25 52 | 81461 | 11 | 18539 | 93508 | 19 | 06492 | 12047 | 8 | 87953 | 16 |
| 45 | 6 34 0 | 5 26 0 | 9.81475 | 11 | 10.18525 | 9.93533 | 19 | 10.06467 | 10.12058 | 8 | 9.87942 | 15 |
| 46 | 33 52 | 26 8 | 81490 | 11 | 18510 | 93559 | 20 | 06441 | 12069 | 8 | 87931 | 14 |
| 47 | 33 44 | 26 16 | 81505 | 12 | 18495 | 93584 | 20 | 06416 | 12080 | 8 | 87920 | 13 |
| 48 | 33 36 | 26 24 | 81519 | 12 | 18481 | 93610 | 20 | 06390 | 12091 | 9 | 87909 | 12 |
| 49 | 33 28 | 26 32 | 81534 | 12 | 18466 | 93636 | 21 | 06364 | 12102 | 9 | 87898 | 11 |
| 50 | 6 33 20 | 5 26 40 | 9.81549 | 12 | 10.18451 | 9.93661 | 21 | 10.06339 | 10.12113 | 9 | 9.87887 | 10 |
| 51 | 33 12 | 26 48 | 81563 | 13 | 18437 | 93687 | 22 | 06313 | 12123 | 9 | 87877 | 9 |
| 52 | 33 4 | 26 56 | 81578 | 13 | 18422 | 93712 | 22 | 06288 | 12134 | 9 | 87866 | 8 |
| 53 | 32 56 | 27 4 | 81592 | 13 | 18408 | 93738 | 23 | 06262 | 12145 | 10 | 87855 | 7 |
| 54 | 32 48 | 27 12 | 81607 | 13 | 18393 | 93763 | 23 | 06237 | 12156 | 10 | 87844 | 6 |
| 55 | 6 32 40 | 5 27 20 | 9.81622 | 14 | 10.18378 | 9.93789 | 23 | 10.06211 | 10.12167 | 10 | 9.87833 | 5 |
| 56 | 32 32 | 27 28 | 81636 | 14 | 18364 | 93814 | 24 | 06186 | 12178 | 10 | 87822 | 4 |
| 57 | 32 24 | 27 36 | 81651 | 14 | 18349 | · 93840 | 24 | 06160 | 12189 | 10 | 87811 | 3 |
| 58 | 32 16 | 27 44 | 81665 | 14 | 18335 | 93865 | 25 | 06135 | 12200 | 10 | 87800 | 2 |
| 59 | 32 8 | 27 52 | 81680 | 15 | 18320 | 93891 | 25 | 06109 | 12211 | 11 | 87789 | 1 |
| 60 | 32 0 | 28 0 | 81694 | 15 | 18306 | 93916 | 26 | 06084 | 12222 | 11 | 87778 | 0 |
| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 130° | | | A | | A | B | | B | C | | C | 49° |

| Seconds of time ...... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. A | 2 | 4 | 6 | 7 | 9 | 11 | 13 |
| B | 3 | 6 | 10 | 13 | 16 | 19 | 22 |
| C | 1 | 3 | 4 | 5 | 7 | 8 | 9 |

TABLE 44. [Page 649

Log. Sines, Tangents, and Secants.

| 41° | | | A | | A | B | | B | C | | C | 138° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 6 32 0 | 5 28 0 | 9.81694 | 0 | 10.18306 | 9.93916 | 0 | 10.06084 | 10.12222 | 0 | 9.87778 | 60 |
| 1 | 31 52 | 28 8 | 81709 | 0 | 18291 | 93942 | 0 | 06058 | 12233 | 0 | 87767 | 59 |
| 2 | 31 44 | 28 16 | 81723 | 0 | 18277 | 93967 | 1 | 06033 | 12244 | 0 | 87756 | 58 |
| 3 | 31 36 | 28 24 | 81738 | 1 | 18262 | 93993 | 1 | 06007 | 12255 | 1 | 87745 | 57 |
| 4 | 31 28 | 28 32 | 81752 | 1 | 18248 | 94018 | 2 | 05982 | 12266 | 1 | 87734 | 56 |
| 5 | 6 31 20 | 5 28 40 | 9.81767 | 1 | 10.18233 | 9.94044 | 2 | 10.05956 | 10.12277 | 1 | 9.87723 | 55 |
| 6 | 31 12 | 28 48 | 81781 | 1 | 18219 | 94069 | 3 | 05931 | 12288 | 1 | 87712 | 54 |
| 7 | 31 4 | 28 56 | 81796 | 2 | 18204 | 94095 | 3 | 05905 | 12299 | 1 | 87701 | 53 |
| 8 | 30 56 | 29 4 | 81810 | 2 | 18190 | 94120 | 3 | 05880 | 12310 | 1 | 87690 | 52 |
| 9 | 30 48 | 29 12 | 81825 | 2 | 18175 | 94146 | 4 | 05854 | 12321 | 2 | 87679 | 51 |
| 10 | 6 30 40 | 5 29 20 | 9.81839 | 2 | 10.18161 | 9.94171 | 4 | 10.05829 | 10.12332 | 2 | 9.87668 | 50 |
| 11 | 30 32 | 29 28 | 81854 | 3 | 18146 | 94197 | 5 | 05803 | 12343 | 2 | 87657 | 49 |
| 12 | 30 24 | 29 36 | 81868 | 3 | 18132 | 94222 | 5 | 05778 | 12354 | 2 | 87646 | 48 |
| 13 | 30 16 | 29 44 | 81882 | 3 | 18118 | 94248 | 6 | 05752 | 12365 | 2 | 87635 | 47 |
| 14 | 30 8 | 29 52 | 81897 | 3 | 18103 | 94273 | 6 | 05727 | 12376 | 3 | 87624 | 46 |
| 15 | 6 30 0 | 5 30 0 | 9.81911 | 4 | 10.18089 | 9.94299 | 6 | 10.05701 | 10.12387 | 3 | 9.87613 | 45 |
| 16 | 29 52 | 30 8 | 81926 | 4 | 18074 | 94324 | 7 | 05676 | 12399 | 3 | 87601 | 44 |
| 17 | 29 44 | 30 16 | 81940 | 4 | 18060 | 94350 | 7 | 05650 | 12410 | 3 | 87590 | 43 |
| 18 | 29 36 | 30 24 | 81955 | 4 | 18045 | 94375 | 8 | 05625 | 12421 | 3 | 87579 | 42 |
| 19 | 29 28 | 30 32 | 81969 | 5 | 18031 | 94401 | 8 | 05599 | 12432 | 4 | 87568 | 41 |
| 20 | 6 29 20 | 5 30 40 | 9.81983 | 5 | 10.18017 | 9.94426 | 8 | 10.05574 | 10.12443 | 4 | 9.87557 | 40 |
| 21 | 29 12 | 30 48 | 81998 | 5 | 18002 | 94452 | 9 | 05548 | 12454 | 4 | 87546 | 39 |
| 22 | 29 4 | 30 56 | 82012 | 5 | 17988 | 94477 | 9 | 05523 | 12465 | 4 | 87535 | 38 |
| 23 | 28 56 | 31 4 | 82026 | 5 | 17974 | 94503 | 10 | 05497 | 12476 | 4 | 87524 | 37 |
| 24 | 28 48 | 31 12 | 82041 | 6 | 17959 | 94528 | 10 | 05472 | 12487 | 4 | 87513 | 36 |
| 25 | 6 28 40 | 5 31 20 | 9.82055 | 6 | 10.17945 | 9.94554 | 11 | 10.05446 | 10.12499 | 5 | 9.87501 | 35 |
| 26 | 28 32 | 31 28 | 82069 | 6 | 17931 | 94579 | 11 | 05421 | 12510 | 5 | 87490 | 34 |
| 27 | 28 24 | 31 36 | 82084 | 6 | 17916 | 94604 | 11 | 05396 | 12521 | 5 | 87479 | 33 |
| 28 | 28 16 | 31 44 | 82098 | 7 | 17902 | 94630 | 12 | 05370 | 12532 | 5 | 87468 | 32 |
| 29 | 28 8 | 31 52 | 82112 | 7 | 17888 | 94655 | 12 | 05345 | 12543 | 5 | 87457 | 31 |
| 30 | 6 28 0 | 5 32 0 | 9.82126 | 7 | 10.17874 | 9.94681 | 13 | 10.05319 | 10.12554 | 6 | 9.87446 | 30 |
| 31 | 27 52 | 32 8 | 82141 | 7 | 17859 | 94706 | 13 | 05294 | 12566 | 6 | 87434 | 29 |
| 32 | 27 44 | 32 16 | 82155 | 8 | 17845 | 94732 | 14 | 05268 | 12577 | 6 | 87423 | 28 |
| 33 | 27 36 | 32 24 | 82169 | 8 | 17831 | 94757 | 14 | 05243 | 12588 | 6 | 87412 | 27 |
| 34 | 27 28 | 32 32 | 82184 | 8 | 17816 | 94783 | 14 | 05217 | 12599 | 6 | 87401 | 26 |
| 35 | 6 27 20 | 5 32 40 | 9.82198 | 8 | 10.17802 | 9.94808 | 15 | 10.05192 | 10.12610 | 7 | 9.87390 | 25 |
| 36 | 27 12 | 32 48 | 82212 | 9 | 17788 | 94834 | 15 | 05166 | 12622 | 7 | 87378 | 24 |
| 37 | 27 4 | 32 56 | 82226 | 9 | 17774 | 94859 | 16 | 05141 | 12633 | 7 | 87367 | 23 |
| 38 | 26 56 | 33 4 | 82240 | 9 | 17760 | 94884 | 16 | 05116 | 12644 | 7 | 87356 | 22 |
| 39 | 26 48 | 33 12 | 82255 | 9 | 17745 | 94910 | 17 | 05090 | 12655 | 7 | 87345 | 21 |
| 40 | 6 26 40 | 5 33 20 | 9.82269 | 10 | 10.17731 | 9.94935 | 17 | 10.05065 | 10.12666 | 7 | 9.87334 | 20 |
| 41 | 26 32 | 33 28 | 82283 | 10 | 17717 | 94961 | 17 | 05039 | 12678 | 8 | 87322 | 19 |
| 42 | 26 24 | 33 36 | 82297 | 10 | 17703 | 94986 | 18 | 05014 | 12689 | 8 | 87311 | 18 |
| 43 | 26 16 | 33 44 | 82311 | 10 | 17689 | 95012 | 18 | 04988 | 12700 | 8 | 87300 | 17 |
| 44 | 26 8 | 33 52 | 82326 | 10 | 17674 | 95037 | 19 | 04963 | 12712 | 8 | 87288 | 16 |
| 45 | 6 26 0 | 5 34 0 | 9.82340 | 11 | 10.17660 | 9.95062 | 19 | 10.04938 | 10.12723 | 8 | 9.87277 | 15 |
| 46 | 25 52 | 34 8 | 82354 | 11 | 17646 | 95088 | 20 | 04912 | 12734 | 9 | 87266 | 14 |
| 47 | 25 44 | 34 16 | 82368 | 11 | 17632 | 95113 | 20 | 04887 | 12745 | 9 | 87255 | 13 |
| 48 | 25 36 | 34 24 | 82382 | 11 | 17618 | 95139 | 20 | 04861 | 12757 | 9 | 87243 | 12 |
| 49 | 25 28 | 34 32 | 82396 | 12 | 17604 | 95164 | 21 | 04836 | 12768 | 9 | 87232 | 11 |
| 50 | 6 25 20 | 5 34 40 | 9.82410 | 12 | 10.17590 | 9.95190 | 21 | 10.04810 | 10.12779 | 9 | 9.87221 | 10 |
| 51 | 25 12 | 34 48 | 82424 | 12 | 17576 | 95215 | 22 | 04785 | 12791 | 10 | 87209 | 9 |
| 52 | 25 4 | 34 56 | 82439 | 12 | 17561 | 95240 | 22 | 04760 | 12802 | 10 | 87198 | 8 |
| 53 | 24 56 | 35 4 | 82453 | 13 | 17547 | 95266 | 22 | 04734 | 12813 | 10 | 87187 | 7 |
| 54 | 24 48 | 35 12 | 82467 | 13 | 17533 | 95291 | 23 | 04709 | 12825 | 10 | 87175 | 6 |
| 55 | 6 24 40 | 5 35 20 | 9.82481 | 13 | 10.17519 | 9.95317 | 23 | 10.04683 | 10.12836 | 10 | 9.87164 | 5 |
| 56 | 24 32 | 35 28 | 82495 | 13 | 17505 | 95342 | 24 | 04658 | 12847 | 10 | 87153 | 4 |
| 57 | 24 24 | 35 36 | 82509 | 14 | 17491 | 95368 | 24 | 04632 | 12859 | 11 | 87141 | 3 |
| 58 | 24 16 | 35 44 | 82523 | 14 | 17477 | 95393 | 25 | 04607 | 12870 | 11 | 87130 | 2 |
| 59 | 24 8 | 35 52 | 82537 | 14 | 17463 | 95418 | 25 | 04582 | 12881 | 11 | 87119 | 1 |
| 60 | 24 0 | 36 0 | 82551 | 14 | 17449 | 95444 | 25 | 04556 | 12893 | 11 | 87107 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 131° | | | A | | A | B | | B | C | | C | 48° |

| Seconds of time ........ | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 2 | 4 | 5 | 7 | 9 | 11 | 12 |
| B | 3 | 6 | 10 | 13 | 16 | 19 | 22 |
| C | 2 | 3 | 4 | 6 | 7 | 8 | 10 |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

| 42° | | | A | | A | B | | B | C | | C | 137° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 6 24 0 | 5 36 0 | 9.82551 | 0 | 10.17449 | 9.95444 | 0 | 10.04556 | 10.12893 | 0 | 9.87107 | 60 |
| 1 | 23 52 | 36 8 | 82565 | 0 | 17435 | 95469 | 0 | 04531 | 12904 | 0 | 87096 | 59 |
| 2 | 23 44 | 36 16 | 82579 | 0 | 17421 | 95495 | 1 | 04505 | 12915 | 0 | 87085 | 58 |
| 3 | 23 36 | 36 24 | 82593 | 1 | 17407 | 95520 | 1 | 04480 | 12927 | 1 | 87073 | 57 |
| 4 | 23 28 | 36 32 | 82607 | 1 | 17393 | 95545 | 2 | 04455 | 12938 | 1 | 87062 | 56 |
| 5 | 6 23 20 | 5 36 40 | 9.82621 | 1 | 10.17379 | 9.95571 | 2 | 10.04429 | 10.12950 | 1 | 9.87050 | 55 |
| 6 | 23 12 | 36 48 | 82635 | 1 | 17365 | 95596 | 3 | 04404 | 12961 | 1 | 87039 | 54 |
| 7 | 23 4 | 36 56 | 82649 | 2 | 17351 | 95622 | 3 | 04378 | 12972 | 1 | 87028 | 53 |
| 8 | 22 56 | 37 4 | 82663 | 2 | 17337 | 95647 | 3 | 04353 | 12984 | 2 | 87016 | 52 |
| 9 | 22 48 | 37 12 | 82677 | 2 | 17323 | 95672 | 4 | 04328 | 12995 | 2 | 87005 | 51 |
| 10 | 6 22 40 | 5 37 20 | 9.82691 | 2 | 10.17309 | 9.95698 | 4 | 10.04302 | 10.13007 | 2 | 9.86993 | 50 |
| 11 | 22 32 | 37 28 | 82705 | 3 | 17295 | 95723 | 5 | 04277 | 13018 | 2 | 86982 | 49 |
| 12 | 22 24 | 37 36 | 82719 | 3 | 17281 | 95748 | 5 | 04252 | 13030 | 2 | 86970 | 48 |
| 13 | 22 16 | 37 44 | 82733 | 3 | 17267 | 95774 | 5 | 04226 | 13041 | 3 | 86959 | 47 |
| 14 | 22 8 | 37 52 | 82747 | 3 | 17253 | 95799 | 6 | 04201 | 13053 | 3 | 86947 | 46 |
| 15 | 6 22 0 | 5 38 0 | 9.82761 | 3 | 10.17239 | 9.95825 | 6 | 10.04175 | 10.13064 | 3 | 9.86936 | 45 |
| 16 | 21 52 | 38 8 | 82775 | 4 | 17225 | 95850 | 7 | 04150 | 13076 | 3 | 86924 | 44 |
| 17 | 21 44 | 38 16 | 82788 | 4 | 17212 | 95875 | 7 | 04125 | 13087 | 3 | 86913 | 43 |
| 18 | 21 36 | 38 24 | 82802 | 4 | 17198 | 95901 | 8 | 04099 | 13098 | 3 | 86902 | 42 |
| 19 | 21 28 | 38 32 | 82816 | 4 | 17184 | 95926 | 8 | 04074 | 13110 | 4 | 86890 | 41 |
| 20 | 6 21 20 | 5 38 40 | 9.82830 | 5 | 10.17170 | 9.95952 | 8 | 10.04048 | 10.13121 | 4 | 9.86879 | 40 |
| 21 | 21 12 | 38 48 | 82844 | 5 | 17156 | 95977 | 9 | 04023 | 13133 | 4 | 86867 | 39 |
| 22 | 21 4 | 38 56 | 82858 | 5 | 17142 | 96002 | 9 | 03998 | 13145 | 4 | 86855 | 38 |
| 23 | 20 56 | 39 4 | 82872 | 5 | 17128 | 96028 | 10 | 03972 | 13156 | 4 | 86844 | 37 |
| 24 | 20 48 | 39 12 | 82885 | 6 | 17115 | 96053 | 10 | 03947 | 13168 | 5 | 86832 | 36 |
| 25 | 6 20 40 | 5 39 20 | 9.82899 | 6 | 10.17101 | 9.96078 | 11 | 10.03922 | 10.13179 | 5 | 9.86821 | 35 |
| 26 | 20 32 | 39 28 | 82913 | 6 | 17087 | 96104 | 11 | 03896 | 13191 | 5 | 86809 | 34 |
| 27 | 20 24 | 39 36 | 82927 | 6 | 17073 | 96129 | 11 | 03871 | 13202 | 5 | 86798 | 33 |
| 28 | 20 16 | 39 44 | 82941 | 6 | 17059 | 96155 | 12 | 03845 | 13214 | 5 | 86786 | 32 |
| 29 | 20 8 | 39 52 | 82955 | 7 | 17045 | 96180 | 12 | 03820 | 13225 | 6 | 86775 | 31 |
| 30 | 6 20 0 | 5 40 0 | 9.82968 | 7 | 10.17032 | 9.96205 | 13 | 10.03795 | 10.13237 | 6 | 9.86763 | 30 |
| 31 | 19 52 | 40 8 | 82982 | 7 | 17018 | 96231 | 13 | 03769 | 13248 | 6 | 86752 | 29 |
| 32 | 19 44 | 40 16 | 82996 | 7 | 17004 | 96256 | 14 | 03744 | 13260 | 6 | 86740 | 28 |
| 33 | 19 36 | 40 24 | 83010 | 8 | 16990 | 96281 | 14 | 03719 | 13272 | 6 | 86728 | 27 |
| 34 | 19 28 | 40 32 | 83023 | 8 | 16977 | 96307 | 14 | 03693 | 13283 | 7 | 86717 | 26 |
| 35 | 6 19 20 | 5 40 40 | 9.83037 | 8 | 10.16963 | 9.96332 | 15 | 10.03668 | 10.13295 | 7 | 9.86705 | 25 |
| 36 | 19 12 | 40 48 | 83051 | 8 | 16949 | 96357 | 15 | 03643 | 13306 | 7 | 86694 | 24 |
| 37 | 19 4 | 40 56 | 83065 | 8 | 16935 | 96383 | 16 | 03617 | 13318 | 7 | 86682 | 23 |
| 38 | 18 56 | 41 4 | 83078 | 9 | 16922 | 96408 | 16 | 03592 | 13330 | 7 | 86670 | 22 |
| 39 | 18 48 | 41 12 | 83092 | 9 | 16908 | 96433 | 16 | 03567 | 13341 | 8 | 86659 | 21 |
| 40 | 6 18 40 | 5 41 20 | 9.83106 | 9 | 10.16894 | 9.96459 | 17 | 10.03541 | 10.13353 | 8 | 9.86647 | 20 |
| 41 | 18 32 | 41 28 | 83120 | 9 | 16880 | 96484 | 17 | 03516 | 13365 | 8 | 86635 | 19 |
| 42 | 18 24 | 41 36 | 83133 | 10 | 16867 | 96510 | 18 | 03490 | 13376 | 8 | 86624 | 18 |
| 43 | 18 16 | 41 44 | 83147 | 10 | 16853 | 96535 | 18 | 03465 | 13388 | 8 | 86612 | 17 |
| 44 | 18 8 | 41 52 | 83161 | 10 | 16839 | 96560 | 19 | 03440 | 13400 | 8 | 86600 | 16 |
| 45 | 6 18 0 | 5 42 0 | 9.83174 | 10 | 10.16826 | 9.96586 | 19 | 10.03414 | 10.13411 | 9 | 9.86589 | 15 |
| 46 | 17 52 | 42 8 | 83188 | 11 | 16812 | 96611 | 19 | 03389 | 13423 | 9 | 86577 | 14 |
| 47 | 17 44 | 42 16 | 83202 | 11 | 16798 | 96636 | 20 | 03364 | 13435 | 9 | 86565 | 13 |
| 48 | 17 36 | 42 24 | 83215 | 11 | 16785 | 96662 | 20 | 03338 | 13446 | 9 | 86554 | 12 |
| 49 | 17 28 | 42 32 | 83229 | 11 | 16771 | 96687 | 21 | 03313 | 13458 | 9 | 86542 | 11 |
| 50 | 6 17 20 | 5 42 40 | 9.83242 | 11 | 10.16758 | 9.96712 | 21 | 10.03288 | 10.13470 | 10 | 9.86530 | 10 |
| 51 | 17 12 | 42 48 | 83256 | 12 | 16744 | 96738 | 22 | 03262 | 13482 | 10 | 86518 | 9 |
| 52 | 17 4 | 42 56 | 83270 | 12 | 16730 | 96763 | 22 | 03237 | 13493 | 10 | 86507 | 8 |
| 53 | 16 56 | 43 4 | 83283 | 12 | 16717 | 96788 | 22 | 03212 | 13505 | 10 | 86495 | 7 |
| 54 | 16 48 | 43 12 | 83297 | 12 | 16703 | 96814 | 23 | 03186 | 13517 | 10 | 86483 | 6 |
| 55 | 6 16 40 | 5 43 20 | 9.83310 | 13 | 10.16690 | 9.96839 | 23 | 10.03161 | 10.13528 | 11 | 9.86472 | 5 |
| 56 | 16 32 | 43 28 | 83324 | 13 | 16676 | 96864 | 24 | 03136 | 13540 | 11 | 86460 | 4 |
| 57 | 16 24 | 43 36 | 83338 | 13 | 16662 | 96890 | 24 | 03110 | 13552 | 11 | 86448 | 3 |
| 58 | 16 16 | 43 44 | 83351 | 13 | 16649 | 96915 | 25 | 03085 | 13564 | 11 | 86436 | 2 |
| 59 | 16 8 | 43 52 | 83365 | 14 | 16635 | 96940 | 25 | 03060 | 13575 | 11 | 86425 | 1 |
| 60 | 16 0 | 44 0 | 83378 | 14 | 16622 | 96966 | 25 | 03034 | 13587 | 12 | 86413 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 132° | | | A | | A | B | | B | C | | C | 47° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 2 | 3 | 5 | 7 | 9 | 10 | 12 |
| B | 3 | 6 | 10 | 13 | 16 | 19 | 22 |
| C | 1 | 3 | 4 | 6 | 7 | 9 | 10 |

TABLE 44. [Page 651

Log. Sines, Tangents, and Secants.

| 43° | | | A | A | B | B | C | | C | 136° |
|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |

| M. | Hour A.M. | Hour P.M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 6 16 0 | 5 44 0 | 9. 83378 | 0 | 10. 16622 | 9. 96966 | 0 | 10. 03034 | 10. 13587 | 0 | 9. 86413 | 60 |
| 1 | 15 52 | 44 8 | 83392 | 0 | 16608 | 96991 | 0 | 03009 | 13599 | 0 | 86401 | 59 |
| 2 | 15 44 | 44 16 | 83405 | 0 | 16595 | 97016 | 1 | 02984 | 13611 | 0 | 86389 | 58 |
| 3 | 15 36 | 44 24 | 83419 | 1 | 16581 | 97042 | 1 | 02958 | 13623 | 1 | 86377 | 57 |
| 4 | 15 28 | 44 32 | 83432 | 1 | 16568 | 97067 | 2 | 02933 | 13634 | 1 | 86366 | 56 |
| 5 | 6 15 20 | 5 44 40 | 9. 83446 | 1 | 10. 16554 | 9. 97092 | 2 | 10. 02908 | 10. 13646 | 1 | 9. 86354 | 55 |
| 6 | 15˙12 | 44 48 | 83459 | 1 | 16541 | 97118 | 3 | 02882 | 13658 | 1 | 86342 | 54 |
| 7 | 15 4 | 44 56 | 83473 | 2 | 16527 | 97143 | 3 | 02857 | 13670 | 1 | 86330 | 53 |
| 8 | 14 56 | 45 4 | 83486 | 2 | 16514 | 97168 | 3 | 02832 | 13682 | 2 | 86318 | 52 |
| 9 | 14 48 | 45 12 | 83500 | 2 | 16500 | 97193 | 4 | 02807 | 13694 | 2 | 86306 | 51 |
| 10 | 6 14 40 | 5 45 20 | 9. 83513 | 2 | 10. 16487 | 9. 97219 | 4 | 10. 02781 | 10. 13705 | 2 | 9. 86295 | 50 |
| 11 | 14 32 | 45 28 | 83527 | 2 | 16473 | 97244 | 5 | 02756 | 13717 | 2 | 86283 | 49 |
| 12 | 14 24 | 45 36 | 83540 | 3 | 16460 | 97269 | 5 | 02731 | 13729 | 2 | 86271 | 48 |
| 13 | 14 16 | 45 44 | 83554 | 3 | 16446 | 97295 | 5 | 02705 | 13741 | 3 | 86259 | 47 |
| 14 | 14 8 | 45 52 | 83567 | 3 | 16433 | 97320 | 6 | 02680 | 13753 | 3 | 86247 | 46 |
| 15 | 6 14 0 | 5 46 0 | 9. 83581 | 3 | 10. 16419 | 9. 97345 | 6 | 10. 02655 | 10. 13765 | 3 | 9. 86235 | 45 |
| 16 | 13 52 | 46 8 | 83594 | 4 | 16406 | 97371 | 7 | 02629 | 13777 | 3 | 86223 | 44 |
| 17 | 13 44 | 46 16 | 83608 | 4 | 16392 | 97396 | 7 | 02604 | 13789 | 3 | 86211 | 43 |
| 18 | 13 36 | 46 24 | 83621 | 4 | 16379 | 97421 | 8 | 02579 | 13800 | 4 | 86200 | 42 |
| 19 | 13 28 | 46 32 | 83634 | 4 | 16366 | 97447 | 8 | 02553 | 13812 | 4 | 86188 | 41 |
| 20 | 6 13 20 | 5 46 40 | 9. 83648 | 4 | 10. 16352 | 9. 97472 | 8 | 10. 02528 | 10. 13824 | 4 | 9. 86176 | 40 |
| 21 | 13 12 | 46 48 | 83661 | 5 | 16339 | 97497 | 9 | 02503 | 13836 | 4 | 86164 | 39 |
| 22 | 13 4 | 46 56 | 83674 | 5 | 16326 | 97523 | 9 | 02477 | 13848 | 4 | 86152 | 38 |
| 23 | 12 56 | 47 4 | 83688 | 5 | 16312 | 97548 | 10 | 02452 | 13860 | 5 | 86140 | 37 |
| 24 | 12 48 | 47 12 | 83701 | 5 | 16299 | 97573 | 10 | 02427 | 13872 | 5 | 86128 | 36 |
| 25 | 6 12 40 | 5 47 20 | 9. 83715 | 6 | 10. 16285 | 9. 97598 | 11 | 10. 02402 | 10. 13884 | 5 | 9. 86116 | 35 |
| 26 | 12 32 | 47 28 | 83728 | 6 | 16272 | 97624 | 11 | 02376 | 13896 | 5 | 86104 | 34 |
| 27 | 12 24 | 47 36 | 83741 | 6 | 16259 | 97649 | 11 | 02351 | 13908 | 5 | 86092 | 33 |
| 28 | 12 16 | 47 44 | 83755 | 6 | 16245 | 97674 | 12 | 02326 | 13920 | 6 | 86080 | 32 |
| 29 | 12 8 | 47 52 | 83768 | 6 | 16232 | 97700 | 12 | 02300 | 13932 | 6 | 86068 | 31 |
| 30 | 6 12 0 | 5 48 0 | 9. 83781 | 7 | 10. 16219 | 9. 97725 | 13 | 10. 02275 | 10. 13944 | 6 | 9. 86056 | 30 |
| 31 | 11 52 | 48 8 | 83795 | 7 | 16205 | 97750 | 13 | 02250 | 13956 | 6 | 86044 | 29 |
| 32 | 11 44 | 48 16 | 83808 | 7 | 16192 | 97776 | 13 | 02224 | 13968 | 6 | 86032 | 28 |
| 33 | 11 36 | 48 24 | 83821 | 7 | 16179 | 97801 | 14 | 02199 | 13980 | 7 | 86020 | 27 |
| 34 | 11 28 | 48 32 | 83834 | 8 | 16166 | 97826 | 14 | 02174 | 13992 | 7 | 86008 | 26 |
| 35 | 6 11 20 | 5 48 40 | 9. 83848 | 8 | 10. 16152 | 9. 97851 | 15 | 10. 02149 | 10. 14004 | 7 | 9. 85996 | 25 |
| 36 | 11 12 | 48 48 | 83861 | 8 | 16139 | •97877 | 15 | 02123 | 14016 | 7 | 85984 | 24 |
| 37 | 11 4 | 48 56 | 83874 | 8 | 16126 | 97902 | 16 | 02098 | 14028 | 7 | 85972 | 23 |
| 38 | 10 56 | 49 4 | 83887 | 8 | 16113 | 97927 | 16 | 02073 | 14040 | 8 | 85960 | 22 |
| 39 | 10 48 | 49 12 | 83901 | 9 | 16099 | 97953 | 16 | 02047 | 14052 | 8 | 85948 | 21 |
| 40 | 6 10 40 | 5 49 20 | 9. 83914 | 9 | 10. 16086 | 9. 97978 | 17 | 10. 02022 | 10. 14064 | 8 | 9. 85936 | 20 |
| 41 | 10 32 | 49 28 | 83927 | 9 | 16073 | 98003 | 17 | 01997 | 14076 | 8 | 85924 | 19 |
| 42 | 10 24 | 49 36 | 83940 | 9 | 16060 | 98029 | 18 | 01971 | 14088 | 8 | 85912 | 18 |
| 43 | 10 16 | 49 44 | 83954 | 10 | 16046 | 98054 | 18 | 01946 | 14100 | 9 | 85900 | 17 |
| 44 | 10 8 | 49 52 | 83967 | 10 | 16033 | 98079 | 19 | 01921 | 14112 | 9 | 85888 | 16 |
| 45 | 6 10 0 | 5 50 0 | 9. 83980 | 10 | 10. 16020 | 9. 98104 | 19 | 10. 01896 | 10. 14124 | 9 | 9. 85876 | 15 |
| 46 | 9 52 | 50 8 | 83993 | 10 | 16007 | 98130 | 19 | 01870 | 14136 | 9 | 85864 | 14 |
| 47 | 9 44 | 50 16 | 84006 | 10 | 15994 | 98155 | 20 | 01845 | 14149 | 9 | 85851 | 13 |
| 48 | 9 36 | 50 24 | 84020 | 11 | 15980 | 98180 | 20 | 01820 | 14161 | 10 | 85839 | 12 |
| 49 | 9 28 | 50 32 | 84033 | 11 | 15967 | 98206 | 21 | 01794 | 14173 | 10 | 85827 | 11 |
| 50 | 6 9 20 | 5 50 40 | 9. 84046 | 11 | 10. 15954 | 9. 98231 | 21 | 10. 01769 | 10. 14185 | 10 | 9. 85815 | 10 |
| 51 | 9 12 | 50 48 | 84059 | 11 | 15941 | 98256 | 22 | 01744 | 14197 | 10 | 85803 | 9 |
| 52 | 9 4 | 50 56 | 84072 | 12 | 15928 | 98281 | 22 | 01719 | 14209 | 10 | 85791 | 8 |
| 53 | 8 56 | 51 4 | 84085 | 12 | 15915 | 98307 | 22 | 01693 | 14221 | 11 | 85779 | 7 |
| 54 | 8 48 | 51 12 | 84098 | 12 | 15902 | 98332 | 23 | 01668 | 14234 | 11 | 85766 | 6 |
| 55 | 6 8 40 | 5 51 20 | 9. 84112 | 12 | 10. 15888 | 9. 98357 | 23 | 10. 01643 | 10. 14246 | 11 | 9. 85754 | 5 |
| 56 | 8 32 | 51 28 | 84125 | 12 | 15875 | 98383 | 24 | 01617 | 14258 | 11 | 85742 | 4 |
| 57 | 8 24 | 51 36 | 84138 | 13 | 15862 | 98408 | 24 | 01592 | 14270 | 11 | 85730 | 3 |
| 58 | 8 16 | 51 44 | 84151 | 13 | 15849 | 98433 | 24 | 01567 | 14282 | 12 | 85718 | 2 |
| 59 | 8 8 | 51 52 | 84164 | 13 | 15836 | 98458 | 25 | 01542 | 14294 | 12 | 85706 | 1 |
| 60 | 8 0 | 52 0 | 84177 | 13 | 15823 | 98484 | 25 | 01516 | 14307 | 12 | 85693 | 0 |

| M. | Hour P.M. | Hour A.M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133° | | | A | | A | B | | B | C | | C | 46° |

| Seconds of time........ | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. {A | 2 | 3 | 5 | 7 | 8 | 10 | 12 |
| B | 3 | 6 | 9 | 13 | 16 | 19 | 22 |
| C | 2 | 3 | 5 | 6 | 8 | 9 | 11 |

# TABLE 44.

## Log. Sines, Tangents, and Secants.

| 44° | | | A | | A | B | | B | C | | C | 135° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. | Hour A. M. | Hour P. M. | Sine. | Diff. | Cosecant. | Tangent. | Diff. | Cotangent. | Secant. | Diff. | Cosine. | M. |
| 0 | 6 8 0 | 5 52 0 | 9.84177 | 0 | 10.15823 | 9.98484 | 0 | 10.01516 | 10.14307 | 0 | 9.85693 | 60 |
| 1 | 7 52 | 52 8 | 84190 | 0 | 15810 | 98509 | 0 | 01491 | 14319 | 0 | 85681 | 59 |
| 2 | 7 44 | 52 16 | 84203 | 0 | 15797 | 98534 | 1 | 01466 | 14331 | 0 | 85669 | 58 |
| 3 | 7 36 | 52 24 | 84216 | 1 | 15784 | 98560 | 1 | 01440 | 14343 | 1 | 85657 | 57 |
| 4 | 7 28 | 52 32 | 84229 | 1 | 15771 | 98585 | 2 | 01415 | 14355 | 1 | 85645 | 56 |
| 5 | 6 7 20 | 5 52 40 | 9.84242 | 1 | 10.15758 | 9.98610 | 2 | 10.01390 | 10.14368 | 1 | 9.85632 | 55 |
| 6 | 7 12 | 52 48 | 84255 | 1 | 15745 | 98635 | 3 | 01365 | 14380 | 1 | 85620 | 54 |
| 7 | 7 4 | 52 56 | 84269 | 2 | 15731 | 98661 | 3 | 01339 | 14392 | 1 | 85608 | 53 |
| 8 | 6 56 | 53 4 | 84282 | 2 | 15718 | 98686 | 3 | 01314 | 14404 | 2 | 85596 | 52 |
| 9 | 6 48 | 53 12 | 84295 | 2 | 15705 | 98711 | 4 | 01289 | 14417 | 2 | 85583 | 51 |
| 10 | 6 6 40 | 5 53 20 | 9.84308 | 2 | 10.15692 | 9.98737 | 4 | 10.01263 | 10.14429 | 2 | 9.85571 | 50 |
| 11 | 6 32 | 53 28 | 84321 | 2 | 15679 | 98762 | 5 | 01238 | 14441 | 2 | 85559 | 49 |
| 12 | 6 24 | 53 36 | 84334 | 3 | 15666 | 98787 | 5 | 01213 | 14453 | 2 | 85547 | 48 |
| 13 | 6 16 | 53 44 | 84347 | 3 | 15653 | 98812 | 5 | 01188 | 14466 | 3 | 85534 | 47 |
| 14 | 6 8 | 53 52 | 84360 | 3 | 15640 | 98838 | 6 | 01162 | 14478 | 3 | 85522 | 46 |
| 15 | 6 6 0 | 5 54 0 | 9.84373 | 3 | 10.15627 | 9.98863 | 6 | 10.01137 | 10.14490 | 3 | 9.85510 | 45 |
| 16 | 5 52 | 54 8 | 84385 | 3 | 15615 | 98888 | 7 | 01112 | 14503 | 3 | 85497 | 44 |
| 17 | 5 44 | 54 16 | 84398 | 4 | 15602 | 98913 | 7 | 01087 | 14515 | 4 | 85485 | 43 |
| 18 | 5 36 | 54 24 | 84411 | 4 | 15589 | 98939 | 8 | 01061 | 14527 | 4 | 85473 | 42 |
| 19 | 5 28 | 54 32 | 84424 | 4 | 15576 | 98964 | 8 | 01036 | 14540 | 4 | 85460 | 41 |
| 20 | 6 5 20 | 5 54 40 | 9.84437 | 4 | 10.15563 | 9.98989 | 8 | 10.01011 | 10.14552 | 4 | 9.85448 | 40 |
| 21 | 5 12 | 54 48 | 84450 | 5 | 15550 | 99015 | 9 | 00985 | 14564 | 4 | 85436 | 39 |
| 22 | 5 4 | 54 56 | 84463 | 5 | 15537 | 99040 | 9 | 00960 | 14577 | 5 | 85423 | 38 |
| 23 | 4 56 | 55 4 | 84476 | 5 | 15524 | 99065 | 10 | 00935 | 14589 | 5 | 85411 | 37 |
| 24 | 4 48 | 55 12 | 84489 | 5 | 15511 | 99090 | 10 | 00910 | 14601 | 5 | 85399 | 36 |
| 25 | 6 4 40 | 5 55 20 | 9.84502 | 5 | 10.15498 | 9.99116 | 11 | 10.00884 | 10.14614 | 5 | 9.85386 | 35 |
| 26 | 4 32 | 55 28 | 84515 | 6 | 15485 | 99141 | 11 | 00859 | 14626 | 5 | 85374 | 34 |
| 27 | 4 24 | 55 36 | 84528 | 6 | 15472 | 99166 | 11 | 00834 | 14639 | 6 | 85361 | 33 |
| 28 | 4 16 | 55 44 | 84540 | 6 | 15460 | 99191 | 12 | 00809 | 14651 | 6 | 85349 | 32 |
| 29 | 4 8 | 55 52 | 84553 | 6 | 15447 | 99217 | 12 | 00783 | 14663 | 6 | 85337 | 31 |
| 30 | 6 4 0 | 5 56 0 | 9.84566 | 6 | 10.15434 | 9.99242 | 13 | 10.00758 | 10.14676 | 6 | 9.85324 | 30 |
| 31 | 3 52 | 56 8 | 84579 | 7 | 15421 | 99267 | 13 | 00733 | 14688 | 6 | 85312 | 29 |
| 32 | 3 44 | 56 16 | 84592 | 7 | 15408 | 99293 | 13 | 00707 | 14701 | 7 | 85299 | 28 |
| 33 | 3 36 | 56 24 | 84605 | 7 | 15395 | 99318 | 14 | 00682 | 14713 | 7 | 85287 | 27 |
| 34 | 3 28 | 56 32 | 84618 | 7 | 15382 | 99343 | 14 | 00657 | 14726 | 7 | 85274 | 26 |
| 35 | 6 3 20 | 5 56 40 | 9.84630 | 8 | 10.15370 | 9.99368 | 15 | 10.00632 | 10.14738 | 7 | 9.85262 | 25 |
| 36 | 3 12 | 56 48 | 84643 | 8 | 15357 | 99394 | 15 | 00606 | 14750 | 7 | 85250 | 24 |
| 37 | 3 4 | 56 56 | 84656 | 8 | 15344 | 99419 | 16 | 00581 | 14763 | 8 | 85237 | 23 |
| 38 | 2 56 | 57 4 | 84669 | 8 | 15331 | 99444 | 16 | 00556 | 14775 | 8 | 85225 | 22 |
| 39 | 2 48 | 57 12 | 84682 | 8 | 15318 | 99469 | 16 | 00531 | 14788 | 8 | 85212 | 21 |
| 40 | 6 2 40 | 5 57 20 | 9.84694 | 9 | 10.15306 | 9.99495 | 17 | 10.00505 | 10.14800 | 8 | 9.85200 | 20 |
| 41 | 2 32 | 57 28 | 84707 | 9 | 15293 | 99520 | 17 | 00480 | 14813 | 8 | 85187 | 19 |
| 42 | 2 24 | 57 36 | 84720 | 9 | 15280 | 99545 | 18 | 00455 | 14825 | 9 | 85175 | 18 |
| 43 | 2 16 | 57 44 | 84733 | 9 | 15267 | 99570 | 18 | 00430 | 14838 | 9 | 85162 | 17 |
| 44 | 2 8 | 57 52 | 84745 | 9 | 15255 | 99596 | 19 | 00404 | 14850 | 9 | 85150 | 16 |
| 45 | 6 2 0 | 5 58 0 | 9.84758 | 10 | 10.15242 | 9.99621 | 19 | 10.00379 | 10.14863 | 9 | 9.85137 | 15 |
| 46 | 1 52 | 58 8 | 84771 | 10 | 15229 | 99646 | 19 | 00354 | 14875 | 10 | 85125 | 14 |
| 47 | 1 44 | 58 16 | 84784 | 10 | 15216 | 99672 | 20 | 00328 | 14888 | 10 | 85112 | 13 |
| 48 | 1 36 | 58 24 | 84796 | 10 | 15204 | 99697 | 20 | 00303 | 14900 | 10 | 85100 | 12 |
| 49 | 1 28 | 58 32 | 84809 | 11 | 15191 | 99722 | 21 | 00278 | 14913 | 10 | 85087 | 11 |
| 50 | 6 1 20 | 5 58 40 | 9.84822 | 11 | 10.15178 | 9.99747 | 21 | 10.00253 | 10.14926 | 10 | 9.85074 | 10 |
| 51 | 1 12 | 58 48 | 84835 | 11 | 15165 | 99773 | 21 | 00227 | 14938 | 11 | 85062 | 9 |
| 52 | 1 4 | 58 56 | 84847 | 11 | 15153 | 99798 | 22 | 00202 | 14951 | 11 | 85049 | 8 |
| 53 | 0 56 | 59 4 | 84860 | 11 | 15140 | 99823 | 22 | 00177 | 14963 | 11 | 85037 | 7 |
| 54 | 0 48 | 59 12 | 84873 | 12 | 15127 | 99848 | 23 | 00152 | 14976 | 11 | 85024 | 6 |
| 55 | 6 0 40 | 5 59 20 | 9.84885 | 12 | 10.15115 | 9.99874 | 23 | 10.00126 | 10.14988 | 11 | 9.85012 | 5 |
| 56 | 0 32 | 59 28 | 84898 | 12 | 15102 | 99899 | 24 | 00101 | 15001 | 12 | 84999 | 4 |
| 57 | 0 24 | 59 36 | 84911 | 12 | 15089 | 99924 | 24 | 00076 | 15014 | 12 | 84986 | 3 |
| 58 | 0 16 | 59 44 | 84923 | 12 | 15077 | 99949 | 24 | 00051 | 15026 | 12 | 84974 | 2 |
| 59 | 0 8 | 59 52 | 84936 | 13 | 15064 | 99975 | 25 | 00025 | 15039 | 12 | 84961 | 1 |
| 60 | 0 0 | 6 0 0 | 84949 | 13 | 15051 | 10.00000 | 25 | 00000 | 15051 | 12 | 84949 | 0 |
| M. | Hour P. M. | Hour A. M. | Cosine. | Diff. | Secant. | Cotangent. | Diff. | Tangent. | Cosecant. | Diff. | Sine. | M. |
| 134° | | | A | | A | B | | B | C | | C | 45° |

| Seconds of time ....... | 1ˢ | 2ˢ | 3ˢ | 4ˢ | 5ˢ | 6ˢ | 7ˢ |
|---|---|---|---|---|---|---|---|
| Prop. parts of cols. { A | 2 | 3 | 5 | 6 | 8 | 10 | 11 |
| B | 3 | 6 | 9 | 13 | 16 | 19 | 22 |
| C | 2 | 3 | 5 | 6 | 8 | 9 | 11 |